

1876

Scientific Review
AND
**SCIENTIFIC AND LITERARY
REVIEW,**

A RECORD OF PROGRESS IN ARTS, INDUSTRY, AND MANUFACTURES,

INCORPORATING THE

Journal of the Inventors' Institute.

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TRANSMISSION ABROAD.]

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2.—The perfect buoyancy of the person when in the water—a pair of these Pillows being capable of supporting a man of 20 stone breast-high.

3.—The protection they afford from floating wreck or dashing against rocks, &c.

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5.—The Pillows being lashed the narrow way across the chest and back, they do not interfere with the action of the arms in any way, and a person could swim, haul a rope, or pull an oar, without the slightest inconvenience.

6.—The slight cost is another feature—because the two Pillows being placed at the head of the mattress make the mattress so much shorter and consequently cheaper.

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**APPLICATIONS FOR
LETTERS PATENT.**

* * In this list (Com.) means Invention communicated from abroad.

Further information, as to the progress of these Patents by Notice to Proceed, Sealing, and Specifying, can be obtained at the Office, 21, Cockspur-street, Charing Cross.

On July 28th.—2664 to 2681.—W. R. Lake. Tickets for railway, steam-boat, and other like purposes (com.)—T. A. Dillon. Method and apparatus for saving life at sea.—T. Messenger and G. D. Churchward. Steam and other engines.—H. Hill. Hair pins.—J. A. L. Spiker. High-pressure steam, water, or other valves.—C. Heinzerling. Manufacture of bichromate of potash, and the manufacture of iodine and bromine.—J. Hindley. Apparatus for lubricating spindles and journals.—W. R. Lake. Tickets for railway, steam-boat, and other like purposes, chiefly designed for long journeys over different railways, or partly by rail and partly by water (com.)—W. J. Halfpenny. Pipes for smoking tobacco.—W. A. Riches. Breech-loading guns.—J. O. Evans. Weaving and apparatus employed therefor.—J. Hanson. Treatment of sewage and the manufacture of manure therefrom.—J. Whitaker. Chaff-cutting machines, also applicable to other descriptions of machinery.—R. Hudson. Construction of waggons and "corves" for carrying coals, clay, sand, ores, or other materials.—H. Rayner and W. Crookes. Process and apparatus for absorbing the acid vapours evolved in various chemical manufactures.—H. E. Newton. Machinery for cutting and folding paper (com.)—J. C. Meason. Gas chandeliers.—G. Speight. Manufacture of luggage labels for tying or fastening upon parcels, luggage, and general merchandise.

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Correspondence.

SIMMONS' PATENT PARAKITE.

To the Editor of the SCIENTIFIC AND LITERARY REVIEW.

SIR,—I take the liberty of asking you to grant me space to subjoin a short description of my patent parakite, which may interest your scientific and amuse your general readers.

Great and hitherto insurmountable difficulties have been experienced in carrying into practical effect with tolerable certainty a means of attaining and retaining an elevated position in the air, for observations in military and other pursuits. For these purposes balloons have been employed occasionally; but gas pipes could seldom, if ever, be laid in positions as required for these aeronautical manoeuvres, and the difficulties, expenses, and uncertainties attending their inflation by any other means, coupled with the difficulty of investing them with ascending power sufficient to attain a considerable altitude in a strong wind, conspire to reduce their utility to a minimum.

I have patented a machine which is intended to convey into the air, human beings, lights, beacons, or other adaptations, for signalling, reconnoitring, surveying or other purposes. Subjoined is a short description of its construction and utility.

The framework consists of a system of canes, kept in their required rigid forms and positions by galvanized steel wire ropes, or other suitable ties. The entire area between the extremities of the frame is then covered by a waterproof and airproof textile fabric, the covering being kept parallel to the earth in order to present the least possible resistance to wind, until the machine is put together ready for the ascent. The time required to fix together the entire framework and covering with a few men or ordinary intelligence would not exceed two hours. The entire machinery attached to the parakite consists of a curious and novel combination of double swivel and pulley, which together weigh not more than 4 lbs. This is fixed to the parakite at its intersection with the cable which is intended to hold the parakite captive, and to prevent the parakite revolving round the axis of the retention cable or centre of force, and also as a means for connecting and retaining the car in a vertical position.

The parakite then having its front point a little elevated from the ground, with a very slight breeze or with a strong wind will be instantly inflated, and if not held down it will ascend to an altitude regulated by the length of cable, and by the obliquity or angle at which the swivel-pulley is fixed. Should it be found that surrounding objects keep the wind off the machine, it can be raised above them by running forward the waggon on which is carried the windlass or drum until an elevation be attained above such sheltering objects.

From the peculiar construction of the surface of the parakite the wind glides from its line of centre towards its extremities, having the form of the letter V, therefore, oscillation is almost absolutely got rid of and a stationary position is obtained when required, which never could be accomplished with a captive balloon having the slightest wind upon its surface.

The parakite will attain the greatest altitude in the strongest wind, with the length of cable unaltered. This is exactly the reverse with captive balloons, and there exists at nearly all times a wind at lofty elevations.

The parakite is not subject to the revolving motion generally experienced with balloons, the advantage in this respect is obvious, from the fact that the portion of the earth before the face of the observer remains relatively stationary as long as the wind continues in one direction; but with the balloon the observer finds it necessary to move around the centre of the car in a direction

contrary to the motion of the balloon, in order to keep the eye fixed on one object or position.

The retention cable is of strength sufficient to sustain the strain necessary to raise the required weight, but of the strength that will ensure the breaking of the cable before the wind will exert a force over the entire resisting surface of the parakite sufficient to tear or rend it. By this means a slow descent with the parakite intact will be the result.

In coming in contact with the earth, consequent upon a descent caused by the breaking of the cable, the surface presented to the wind will be very small compared with that of a balloon, from the fact that as long as the parakite is parallel to the wind it merely presents edge resistance.

The entire machine with all its appurtenances (except the windlass) may be packed in a case seven feet long twelve inches square or less.

Different sizes may be constructed to suit the varying force of the wind, or the surface of a large one may be reefed or contracted.

I intend in the course of a few days to conduct an experiment with one of my small machines, which will be open to the public in Hyde Park, and you will confer upon me a great favour by permitting me here to entreat all those who may attend not to crowd upon me during the experiment. No person will on this occasion attempt to ascend, but the object will be to demonstrate the utility and safety of the apparatus when applied to its ultimate purpose. The public demonstration will be duly advertised, and the press are respectfully solicited to accept this as an invitation to witness the experiment.—I remain, Sir, your obedient servant,

JOSEPH SIMMONS, Aeronaut.

38, Regent-street, London, W.

ORIGIN OF THE NUMERALS.

"ALTHOUGH the origin of our present system of numerical notation is unknown, there is no doubt that it was in use amongst the Hindus two thousand years ago." Thus it is written in Brande and Cox's "Dictionary of Science Literature and Art," nor has a search in other quarters been more successful in finding any attempt at solving the problem. Consequently the following hypothesis is calculated to interest the many and to commend itself as satisfactory to the critical few:—

\	/	1
=	z	2
≡	z	3
□	△	4
5	5	5
△	6	6
8	7	7
8	8	8
8	9	9

The first column contains the original symbols consisting of as many notches each as the number which the figure is intended to represent.

The next column shows the transitional stage due to careless and rapid execution, and verified by reference to early manuscripts and books.

The third contains the worn forms of today.

The written four (4) shows that the figure was begun at the top. And the written nine (9) is the older form, the printed form like an inverted six (9) being a comparatively modern innovation.

W. DONIS THORPE.

Bebick.

BLOWPIPE GUIDE.

"Practical Guide to the Determination of Minerals by the Blowpipe." By Dr. C. W. C. Fuchs. Translated and edited by T. W. Danby, M.A. Field and Tuer.

This is a work of a most important kind, and in it the reactions of each elementary substance before the blowpipe are considered seriatim. A table is appended, showing the hardness and specific gravity of minerals, and the crystallographic system to which their forms belong, together with some of their more important synonyms.

THE TREASURY OF LITERATURE AND LADIES' TREASURY, edited by Mrs. Warren.—We are glad to find that this very valuable serial is progressing favourably. Mrs. Warren provides for her readers information as to fashion, as to needlework (cut out patterns being distributed with the publication), also much useful knowledge as to domestic matters is supplied side by side with literary production of a high order.

THE HISTORY OF ENGLAND.—A new edition is announced of "Cassell's History of England," in monthly parts. This is the history of which Lord Brougham said, "The soundest principles are laid down in almost every instance. The interests of virtue, of liberty, and of peace—the best interests of mankind—are faithfully and ably maintained throughout." It will be illustrated with upwards of 2,000 engravings, and a new portrait of Her Majesty the Queen, produced in the best form of art, and printed on imperial plate paper, two ft. six in. by one ft. ten in., will be issued as a presentation plate with the first monthly part, which will be published on September 27th.

POSTPONEMENTS.—Reviews on Swinburne's "Essays," Dr. Letheby "On Noxious and Offensive Trades," and other articles are deferred for want of space.

WASTE OF COAL IN CORNISH MINES.—It was shown by Mr. Basset, of Tehidy, at the meeting of the Royal Cornwall Polytechnic Society held recently, when offering £200 towards a premium of not less than £500 for a boring machine capable in an appreciable degree of expediting and economising the working and driving of Cornish mines at a depth of not less than one hundred fathoms from surface, that the Cornish engines during the first six months of 1875 did with the same consumption of coal less than one-third the work which was actually done with the United Mines engine half a century ago. Can Cornishmen do nothing to remove such a stigma?—*Mining Journal*.

SCIENTIFIC REVIEW

AND

Scientific and Literary Review.

A RECORD OF PROGRESS IN

ARTS, INDUSTRY, AND MANUFACTURES,

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JOURNAL OF THE INVENTORS' INSTITUTE.

OCTOBER 1, 1875.

REFORM IN COPYRIGHT AND PATENTRIGHT.

INVENTORS often point to their brother workers in intellectual industry—authors—as favourites of the law; yet authors are anything but satisfied, although copyright is conceded to their works for *nothing* (the five shilling registration at Stationers' Hall being simply necessary to enable them to carry on law process against infringers, and capable of being effected at any time before commencing such process). They are by the present law subject to a variety of legal quibbles and nice distinctions, which lead to anything but nice results.

Efforts have, therefore, been made to get these laws overhauled, with the view to their improvement, and have resulted in the subject now being placed by the Government in train for consideration. We hope the result will be that something like a perfect code of Copyright Law will be produced.

International Copyright and Canadian Copyright have recently been dealt with by Parliament, and we see no reason why the whole question should not be brought to a satisfactory settlement. At the same time, we must urge that the claims of inventors to better laws as regards according to, and assuring them in, the temporary exclusive possession of their own inventions, are even more urgent than those of authors, as inventors have, as the law now stands, large sums to pay before they can call their inventions their own; and have, moreover, a complete network of legal subtleties to escape from in order to obtain the beneficial enjoyment of the products of their industry.

The proceedings of the Government in the last Session of Parliament do not encourage any very sanguine expectations, but we may still hope for the best; especially if inventors will themselves press on in good earnest, simply restricting their demands to reduction of charges for protection to a trifling sum, facile arrangements for ascertaining the novelty of inventions and validity of patents, and something like a rational system of legal procedure. That much may be done to advance the interests of inventors by very simple changes will be seen by considering the very great importance of the following proposition of the French Government, which, if persistently carried

out, will render the investigation of the novelty and validity of any French patent comparatively easy:—

The French Minister of Agriculture and Commerce, in a letter addressed to the prefects, states that Article 23 of the law of 5th July, 1844, provides that the specifications of inventions patented each year, or abstracts of them, be published. Hitherto they have been issued in the form of a volume, comprising branches of industry the most varied, and often having no connection one with another, so that to obtain any desired information it was necessary to buy each volume as it appeared, and then to make a long and tedious search. In future, however, the patents will be divided into twenty groups, comprising agriculture, hydraulics, railways, textile manufactures, engines, ships and navigation, civil constructions, mining and metallurgy, domestic appliances, carriages, fire-arms and artillery, instruments of precision, fictile art, chemistry, lighting and heating, wearing apparel, industrial arts, paper making, leather and skins, Paris goods, and minor industries.

Each of these groups is again divided into a certain number of classes relating more particularly to branches of trade either of the same nature or having the same object. Thus, agriculture comprises five classes:—1, agricultural machines; 2, manure; 3, works connected with the management of farms (*travaux d'exploitation*); 4, mill work; 5, bread making.

Each of these classes forms the subject of a separate publication, in the form of parts (*fascicules*), containing the text and plates if required. These parts will be sold separately at a price regulated by the number of sheets and plates, at the rate of 40 centimes (4l.) per sheet and per plate. The parts will be collected into volumes, which will be sold, as heretofore, at 15 frs. (12s.) each.

Now that the new method of publication has been adopted, the specifications deposited since 1861 are to be published. As it was thought interesting to bring to the knowledge of the public the most recent patents, it has been decided to publish simultaneously the patents of 1861 and 1871, of 1862 and 1872, of 1863 and 1873, and so on; a certain number of parts relating to the year 1873 are now to be obtained. The sale of the parts and volumes take place at the Imprimerie Nationale, Paris, Rue Vieille-du-Temple, 87.

A table giving the title and the price of the parts that have appeared up to the present time has been prepared, and the titles and prices of future parts will be announced in the *Journal Officiel*.

This proposition of the French Government is only carrying out in a more practical way the system of classified abridgments issued by our Patent Office, and we commend it to the notice of Her Majesty's Commissioners of Patents for Inventions for we consider the adoption of the above plan would enable Inventors themselves to effect the preliminary Examination which is a *questio vexata* of Patent Reform.

BRITISH ASSOCIATION.

MATHEMATICAL AND PHYSICAL SCIENCE.—The President, Prof. Balfour Stewart, devoted his opening address to an outline of modern discoveries regarding the physical constitution of the sun. Nearly fifty years have elapsed since Schwabe began his daily sketches of the sun's spots, which resulted in the discovery of the now well-known period of 11½ years. Carrington, for seven years, commencing with 1854, made accurate sketches of all spots, and determined their solar latitudes and longitudes. Celestial photography, commenced by De la Rue, was taken up by the Kew Committee of the British Association, and ten years of solar photographs were obtained, commencing with 1862. Before this date, however, Mr. De la Rue had ascertained, by means of his photoheliograph, on the occasion of the total eclipse of 1860, that the red prominences surrounding the eclipsed sun belong, without doubt, to our luminary himself.

The Kew photographs confirm the theory of Wilson that sun-spots are phenomena, the dark portions of which exist at a level considerably below the general surface of the sun. The Kew observers were, likewise, led to associate the low temperature of the bottom of the spots with the downward carriage of colder matter from the atmosphere of the sun, while the upward rush of heated matter was supposed to account for the faculae or bright patches which almost invariably accompany spots. The Kew observers (notably Prof. Stewart himself) have further discovered traces of the influence of the nearer planets upon the behaviour of spots, the influence being of such a nature that spots attain their maximum size when carried by rotation into positions as far as possible remote from the influencing planet. The cause of the 11½ year period has, however, not yet been properly explained.

While the sun's surface was thus being examined photographically, the spectroscope came to be employed as an instrument of research. It had already been surmised by Prof. Stokes that the vapour of sodium at a comparatively low temperature forms one of the constituents of the solar atmosphere, inasmuch as the dark line D in the spectrum of the sun coincides in position with the bright line given out by incandescent sodium vapour. This method of research was greatly extended by Kirchhoff, who found that many of the dark lines in the solar spectrum were coincident with the bright lines of sundry incandescent metallic vapours.

It was soon found that the fixed stars had constitutions very similar to that of the sun, and Huggins showed that most of the nebulae which had not been resolved by telescopes into clusters of stars gave indications of incandescent hydrogen. It was also found by this observer that the proper motions of some of the fixed stars in a direction to or from the earth might be detected by means of the displacement of their spectral lines, a method of research which was first enunciated by Fizeau.

It had not yet been attempted to examine particular districts of the sun; this was first done by Mr. Lockyer, who in 1865 examined a sun-spot spectroscopically, and remarked the greater thickness of the lines in its spectrum. Prof. Frankland had previously found that thick spectral lines correspond to great pressure.

Mr. Lockyer next caused a powerful instrument to be constructed for the purpose of viewing spectroscopically the red flames round the sun's border, in the hope that if they consisted of ignited gas the spectroscope would disperse, and thus dilute and destroy the glare which prevents them from being seen on ordinary occasions. This hope was realised; but, before the completion of the instrument, the red flames had been analyzed by the observers of a total eclipse in India, and one of them (M. Janssen) made the important observation that

the bright lines in the spectrum of these flames remained visible even after the sun had reappeared. After the completion of his instrument, Mr. Lockyer found by deliberate observations that the sun is surrounded by an atmosphere of incandescent hydrogen, into which during the greater solar storms sundry metallic vapours were ejected, especially sodium, magnesium, and iron.

More recently, the same observer has explained the circumstance that, in the reversed spectra of metals as seen in the sun, some lines are wanting. He found, on observing separately the spectra of different parts of the discharge given between electrodes of a metal by an induction coil, that, while all the lines are present near the poles, some are wanting in the central region, and these are the same as those which are wanting in the sun.

The application of photography to spectrum observations was first commenced on a sufficient scale by Rutherford, of New York.

Respecting the sun's corona, we are now certain that a large part of this appendage unmistakably belongs to our luminary; and in the next place we know that it consists, in part at least, of an ignited gas, giving a peculiar spectrum, which we have not yet been able to identify with that of any known element. The temptation is great to associate this spectrum with the presence of something lighter than hydrogen, of the nature of which we are yet totally ignorant.

There are strong grounds for supposing that the meteorology of the sun and that of the earth are connected together. Mr. Broun has shown the existence of a meteorological period connected apparently with the sun's rotation, five successive years' observations of the barometer at Singapore concurring in giving a period of 25·74 days; Meldrum has shown that the cyclones in the Indian Ocean are most frequent in years when there are most sun-spots. Other observers have brought to light a cycle of terrestrial temperature, having apparent reference to the condition of the sun.

In terrestrial magnetism the same connection is apparent. Sabine was the first to show that magnetic disturbances are most violent during years of maximum spots, and Mr. Broun has shown that there is in magnetic phenomena a reference to the sun's period of rotation on his axis.

Prof. Stewart went on to speculate regarding the nature of this connection, alleging the possibility that the earth's magnetism is not directly influenced by the sun's action, but indirectly through the effect of the sun upon terrestrial meteorology.

The return trades that pass above from the hotter equatorial regions to the poles of cold, consisting of moist rarefied air, are to be regarded in the light of good conductors crossing lines of magnetic force; we may, therefore, expect them to be the vehicle of electric currents. Such electric currents will react on the magnetism of the earth; and since the velocity of these upper air-currents has a daily variation, their influence, as exhibited at any place upon the magnetism of the earth, may be expected to have a daily variation also.

The first paper read was the "Report on Underground Temperature," by Prof. Everett.

Mr. Hopkinson (of Messrs. Chance's glass works, Birmingham) gave an account of the attempts which he has made, at the request of Prof. Stokes, to produce a titano-silicic glass suitable for destroying the secondary spectrum in an achromatic combination. The late Mr. Vernon Harcourt succeeded in destroying the secondary spectrum by the use of a phosphatic glass, which, however, has the fault of being exceedingly liable to tarnish. It was hoped that titano-silicic glass would answer the same purpose and have the advantage of greater durability; but this hope has been disappointed. Good

specimens of this glass have been prepared, but they have been found not to possess the peculiar qualities, as regards dispersion of the red and blue ends of the spectrum, which are requisite for the object in view, and which are possessed by the phosphatic glass, Prof. Stokes having exhibited last year at the Belfast meeting a perfectly achromatic combination in which the latter was one of the two constituents.

Prof. Osborne Reynolds, of Owens College, then gave an account of his researches on the refraction of sound. On the same principle that rays of light are usually bent downwards in traversing the atmosphere, rays of sound are usually bent upwards; light travelling faster in rare than in dense air, but sound travelling faster in warm than in cold air, irrespective of density. The air is usually warmest near the ground; the lower part of a plane wave-front of sound will therefore advance faster than the upper part, and the direction of advance being always perpendicular to the front will be bent upwards in a curve whose radius will be about twenty miles, when the difference of temperature is a degree Fahrenheit per 100 feet. He regarded this as the true explanation of the remarkable phenomena observed by Prof. Tyndall in connection with fog-horns, and described further experiments made by himself, which appeared to confirm the view.

In the discussion which ensued, the first part of the paper received the warm approval of the President and Prof. Everett; but an attempt made by Prof. Reynolds to explain the non-audibility at Montlery of a gun fired at Villejuif, in a certain memorable experiment when a similar gun at Montlery was heard at Villejuif, did not give equal satisfaction. Prof. Reynolds maintained that sound produced at the top of a tower is audible on the ground when sound produced on the ground is not audible on the tower. Lord Rayleigh, on the other hand, asserted, as a principle which had received mathematical demonstration, that an interchange of the positions of the source and the observer made no difference in the intensity observed. This, indeed, is a particular case of a very important general theorem on reciprocity recently published by Lord Rayleigh and accepted by mathematicians.

A paper by a young physicist, Mr. J. A. Fleming, giving an account of some experiments in which he had obtained evidence of an electric current produced by the flow of an electrolyte across a magnetic field, elicited much commendation.

Rev. S. J. Perry made some remarks from his own experience of the English Expedition to the Island of Kerguelen for observing the Transit of Venus, which resulted in obtaining some good photographs of the egress of the planet.

Captain H. Toynbee, F.R.A.S., F.R.G.S., &c., Marine Superintendent of the Meteorological Office, read a paper on the physical geography of that part of the Atlantic Doldrums which lies in the track of ships crossing the Equator. The paper was accompanied by diagrams which showed, first, the isobaric lines of mean pressure for each 0·5 of an inch, together with arrows showing the prevailing winds and their force; secondly, the isothermal lines for every second degree of air temperature; and, thirdly, the isothermal lines for every second degree of sea temperature, together with arrows showing the prevailing currents and their speed in 24 hours. The paper called attention to important facts relating to atmospheric pressure, temperature, wind, currents, weather, sea, clouds, natural history, earthquakes, &c. The whole paper may be said to be a *résumé* of a large work about to be published by the Meteorological Office, which is under the superintendence of the Meteorological Committee of the Royal Society.

"The Effects of Stress on the Magnetism of Soft Iron" and "Some results of Laplace's

Theory of Tides" were the subject of two memoirs by Sir William Thompson. Mr. Philip Braham exhibited experiments on magnetized plates and discs of hardened steel, and Professor W. F. Barrett read a paper on "The Effects of Heat on the Molecular Structure of Steel." When an iron or steel wire is allowed to cool slowly from a high temperature to a dull red heat, it suddenly rises in temperature, glows with a bright red heat, and increases in length; it then cools again and continues to cool and shorten without any further discontinuity. The change is accompanied by a series of ticking sounds, like scraping on the edge of a plate with a jagged knife. A converse change occurs when heat is continuously applied to raise the wire from a low temperature to a bright red heat; when it has attained a dull red heat it suddenly ceases to rise in temperature and to expand, and the temperature at which the discontinuity occurs is the same in both cases. It is precisely at this temperature that the wire loses its magnetic susceptibility in heating and resumes it in cooling. It was very striking to see the sudden deflection of a needle placed near the wire precisely at the moment of the sudden glow. It is also at this temperature that the wire undergoes that reversal of its thermo-electric qualities which was discovered two or three years ago by Prof. Tait.

Capt. Abney, R.E., described a result which had been observed in some experiments made for Government upon magneto-electric machines. It was found that the numbers denoting the light emitted at different speeds of revolution were not the same when the comparison was made by eye observation as when it was made by photography. The actinic effect was proportionally less at low than at high speeds.

Prof. A. S. Herschel described further experiments, which he had made in conjunction with Mr. G. A. Lebour, on the conductivity of rocks. Quartz was the best and coal the worst conductor; and, contrary to what was expected, rocks with slaty cleavage were found to conduct better across than along the planes of lamination.

Prof. Clifford astonished the section by some remarkable applications of Grassmann's "polar multiplication" defined by the law that $b \wedge a$ is minus $a \wedge b$. He applied it to the graphical representation of invariants, to the expansion of unsymmetrical functions, and to the notation of matrices, illustrating his remarks by drawings representing atoms hung together in various ways. Mr. Spottiswoode read the report of the committee on mathematical printing, and handed round diagrams exhibiting the several pieces which must be put together by the compositor in setting up various specimens of mathematical formulæ. The object of the committee is to direct mathematicians how to write their formulæ so that they may be printed with the least labour and expense.

A Report on Mathematical Tables by Professor Cayley; a Report on Hyperelliptic Functions by Mr. W. H. L. Russell; three Mathematical Investigations by Sir William Thompson, three by Professor Smith, one by Professor Clifford, two by Mr. H. M. Jeffery, two by Mr. J. W. L. Glaisher, one by Professor Everitt, one by Professor R. S. Ball, and two by Professor Paul Mansion, were presented.

Mr. James Glaisher read the report of the Committee on Luminous Meteors. He described the recent falls of four aerolites and the fall of a meteoric iron in North Carolina, and the appearance of large meteoric appearances, especially in England and France. The Committee have been reducing observations and intend to provide new meteor charts.

Mr. G. J. Symons then gave the report of the Rainfall Committee. It gives an

epitome of rainfall work done by the British Association during the last fourteen years, and refers to steps taken after the meeting at Belfast to obtain additional stations in Ireland. Out of 190 stations offered, they selected sixty-six, many in localities of extreme importance. After referring to other work, the report is as follows:—

"In the past fifteen years the number of stations has been raised from 241 to nearly 2,000. The influence of size and shape on the indications of rain gauges has been experimentally examined, and also the effect of height above ground. The laws which regulate the seasonal distribution of rainfall have been ascertained. The secular variation of annual fall has been approximately determined. A code of rules has been drawn up for observers. Nearly 250 stations have been started at the cost of the association, and 629 stations have been visited and the gauges examined by our secretary. We have obtained and supported observations on mountain tops, and other inaccessible places where no observations had been made, in Cumberland, Westmoreland, Wales, and Scotland, and also an extensive series in Ireland. When the works actually in hand are completed, we shall also have furnished an index to all observations hitherto made, and a guide to the value to be attached to the returns from at least a thousand. Irrespective, however, of any future work, they have had the satisfaction of assisting to make the rainfall system of the British Isles the most nearly perfect in the world."

Professor Hennesy then read two valuable papers on the effect of water surface on climate. In the first paper he deduced the laws that water was the most powerful agent in receiving and retaining the heat of the sun, and had a general tendency to equalize the temperature over the globe. These results have been adopted and used by the late Professor Phillips and Dr. Carpenter. In his second paper he said that were it possible to convert the great Sahara desert into a lake the effect would be beneficial to Western Asia and not injurious to Africa or elsewhere. Captain Abney then read a paper on the electric light. Mr. H. A. Roland read two papers on the subject of magnetism; and the day's proceedings were terminated by a letter on Rainfall Periodicity.

Mr. N. Lowenthal Lonsdale then read a memoir, "On Mechanical Self-registering Apparatus for Barometers, Thermometers, Rain and Wind Gauges," and Professor W. F. Barrett "On a Self-registering Rain Gauge." Mr. G. J. Symons then gave an account of the remarkable rainfall which occurred on the 14th of July in Monmouthshire and other places. The fall began in the extreme west of Pembrokehire about midnight of the 13th and 14th of July. Its front wall advanced in a north-easterly direction at the rate of about eighteen miles an hour. It reached Norfolk about 4 p.m. on the 14th. The average duration was thirty-six hours, and at one station the amount of rainfall in twenty-four hours reached the unprecedented figure of 5.31 in.; but at places north of latitude fifty-three the rainfall in the twenty-four hours was one inch, while at places south of that it was five inches.

CHEMICAL SCIENCE.—The President, Mr. A. G. Vernon Harcourt, M.A., F.R.S., began his address by pointing out that there was now no need for reviewing the progress of chemistry during the past year, since the *Journal of the Chemical Society*, with its abstracts from foreign papers, may be looked upon as a complete record of chemical research. In this plea for omitting to summarize the work of the year we cannot entirely agree with the distinguished speaker. Surely a somewhat promiscuous collection of papers on researches in the most widely differing branches of chemistry will never be to the student what a well-digested and clearly-pointed *resume* would

be? As Mr. Harcourt himself stated, in the course of his address, "not every fact, however laboriously attained and rigorously proved, is an important fact in chemistry any more than in other branches of knowledge. Our aim is to discover the laws which govern the transformations of matter, and we are occupied in amassing a vast collection of receipts for the preparation of different substances, and facts as to their composition and properties, which may be of no more service to the generalizations of the science, whenever our Newton arises, than were, I conceive the bulk of the stars to the conception of gravitation." Why, then, not direct the attention of the student to what may be considered as an "important" contribution to the year's work in chemistry?

After a passing remark on the nature of the advancement in chemical science, the President proceeded to consider the causes of the backwardness of Great Britain in the pursuit of original research. He does not hesitate to assign this deplorable condition to the ignoring of the claims of chemistry to its place in general education. It is not enough that there is now provision for the study of chemistry in the higher schools. He justly says that "the Universities have little power to determine what number of students shall follow any particular line of study. With certain reserves in favour of classics and mathematics, their system is that of free trade. Young men of eighteen or nineteen have tastes already formed, some for the studies which were put before them at school, in which, perhaps, they are already proficient and have been already successful, some for games and good-fellowship. It is, from the nature of the case, with the masters of schools that the responsibility rests of fixing the position of science in education."

A good deal, as Mr. Harcourt said, has been done in the last ten years for the acclimatization of chemistry in our great schools; but we concur in his view that considerably more has yet to be done in this respect. Why chemistry and physics are, as far as we are aware, in all public schools, as yet only optional subjects, *i.e.*, the parent—who in nine cases out of ten knows nothing more of chemistry and physics than just their names—is to decide whether those two branches of natural science are or are not to have their share in the development of his child's mind.

It is only when the school has done its duty that the universities may be expected to fulfil their proper functions.

To accelerate the progress of chemical science, Mr. Harcourt would like to see "chemists organized into working parties, having each a definite region to explore," and the formation of "a committee, which should put itself into communication with the leaders of chemical inquiry abroad, and should make and obtain and publish suggestions of subjects for research."

Undoubtedly this sounds nice. But is it a workable idea? Moreover, would there be any need of such a committee, if chemical teaching at the Universities and in the higher schools would be what it is, for instance, Germany, where the heads of scientific laboratories exactly do the work of Mr. Harcourt's committee, inasmuch as they direct the successive generation of young chemists, who have passed beyond the stage of elementary study, into the right channels? But the directing activity is denied to the heads of schools of chemistry in England, as long as they have to do the work, which, as we indicated above, should be performed by the boy schools. The brilliant powers of some of our great chemists are simply wasted year after year in the teaching of the merest rudiments of the science to lads who might very well have acquired them before reaching the higher schools.

The president's observations on the exaggerated value attributed to the study

of constitutional formulæ are admirable. There is a school of chemists, chiefly younger men, growing up in England as well as in Germany, which believes the elaboration of letters and figures in all imaginable positions to be the sum and substance of chemical theory. These men are entirely ignorant of the spirit in which the modern symbolic language of chemistry has been devised by its originators, and they will do well to reflect upon Mr. Harcourt's remarks.

The address concluded by briefly referring to the connection between pure and applied chemistry, and stating that "the estimation of our sciences by the outside world rests largely on the well-founded belief that chemistry is useful. Indeed, though scientific chemists are justly eager to vindicate the value of investigations remote from any application to the arts, they cannot but feel a livelier sense of triumph when the successful synthesis of a vegetable principle yields also a product of great technical value in the arts, as in the case of the production of artificial alizarin."

Mr. T. E. Thorpe read a Report of the Committee engaged upon determining the specific volumes of liquids. The report, after stating that almost the whole of our present knowledge on this subject was due to Kopp's laborious researches, gave a summary of the experiments made by the Committee, chiefly with the view of ascertaining the correctness of the laws enunciated by Kopp.

Mr. W. C. Roberts communicated a short note on the work of the Committee investigating the methods for making gold assays. The Committee state that the standard gold plate, which has been for a length of time in preparation, has been finished, and that portions of it have been forwarded to different mints for the purpose of being assayed. The reports are very satisfactory, that of Prof. Stas, of Brussels, giving 999.95 parts of pure gold out of 1,000 parts. This same plate has been examined by Mr. Lockyer by means of the spectro-scope, and the lines have been compared side by side with the solar lines. By this method it has been shown that silver, copper, and iron are absent, and that consequently the purification of the metal has succeeded very well.

Mr. H. T. Chamberlain read a paper "On the Manufactures and Refining of Sugar in Bristol," and Mr. T. Davey read a paper "On the Tobacco Trade of Bristol."

A paper was next read by Mr. A. S. Davis, upon a simple method of determining the amount of carbon acid in the air.

"On the Estimation of Sulphur in Coal Gas," was the title of a paper by Mr. Vernon Harcourt. By the present system of gas making it appears impossible for gas manufacturers altogether to prevent sulphur, in the form of bisulphide of carbon, from entering and contaminating the gas; and as Parliament has fixed for the metropolitan companies a limit for the impurity beyond which they may not go, it is a desideratum to have a simple and approximately correct process for the estimation of the amount of this impurity. Mr. Harcourt's process is founded upon the fact that when bisulphide of carbon is heated in presence of hydrogen it is decomposed into sulphuretted hydrogen, and this sulphuretted hydrogen has the property of converting a lead salt into the black sulphide of lead. The estimation is made in the following manner:—A volume of coal gas is passed through a flask filled with small pebbles, kept at a low red heat, when the above reaction takes place; the gas is then passed through a solution containing a lead salt, until a definite brown or black tint is produced. This tint is compared with a standard colour, and the amount of sulphur in the gas is calculated from this.

Papers "On Japanese Camphor from Peppermint," and "On the Alkaloids of the

Aconites," by Mr. G. H. Beckett and Dr. C. R. A. Wright, were then read by the secretary. These were followed by two others, also read by the secretary, "On the Action of Ethyl Bromobutyrate on Ethyl Acetosuccinate," by Mr. F. Clowes, and "On Noctilucine," by Dr. T. L. Phipson.

Prof. Cayley read a paper "On Analytical Forms called Trees with Application to the Theory of Chemical Combination." The subject was more mathematical than chemical, its object being to solve the theory of the combination of atoms of paraffin. By calling points knots and lines branches, the Professor constructed several diagrams which he termed trees, the total number of which was about 790. A nitrogen atom would link itself with a single atom only, but one atom of carbon with four atoms, two carbon with six hydrogen, three carbon would take up eight, &c.

Mr. A. H. Allen presented the report of the committee for the purpose of examining and reporting upon the methods employed in the estimation of potash and phosphoric acid in commercial products, and on the mode of stating the results. The committee, it seems, originated in a desire to avoid some discrepancies in the chemical analysis of manures and potash salts, which, to a certain extent, disgraced chemists, and which caused considerable difficulty in the valuation of manures. The committee endeavoured to ascertain as far as possible the details of methods of examining phosphates and potash salts, and to learn the opinions of chemists employing them as to their special advantages and limits of error, and to collect information on closely allied matters. A circular was sent to the members of the Chemical Society and other gentlemen likely to render assistance. Some chemists replied that they did not see that they were under any obligation to publish results which they regarded in the light of trade secrets. The committee gave an epitome of the very voluminous replies which had been received. There were many points in which the evidence was very conflicting, and the committee felt it impossible to recommend with confidence any particular process or processes unless the special conditions of accuracy were very clearly defined. The large amount of information amassed during the past year had indicated very distinctly the direction in which further research was desirable, and the committee, therefore, asked to be reappointed, believing that before the next meeting of the association it will be able to complete the proposed experiments and inquiries, and make a full report on the whole subject it was appointed to investigate.

The report of the sewage committee, read by Professor Corfield, described the results of experiments which have been continued at Breton's sewage farm, near Romford.

Mr. J. C. Melliss read a paper "On the Treatment of Sewage." His observations had reference principally to the town of Coventry, where there is a daily flow of two million gallons of polluting liquid, being the whole sewage and manufacturing refuse of that town. This noxious matter had, however, been diverted from the river and so completely purified as to satisfy all parties concerned in the neighbourhood. Not only in a sanitary point of view was the purification approved of, but the return of fishes to the river testified to the value of the work which had been accomplished. The effluent water, as it passed into the river, was clear and bright, and of a high standard of purity, had no perceptible smell, and was almost free from colour.

Short papers, "On the Oxidation of Essential Oils," by Mr. C. T. Kingzett; "On Oxyvitic Acid," by Prof. A. Oppenheim; and "On Mercaptan Derivatives," by Mr. L. Jackson and Prof. A. Oppenheim, concluded the meeting.

In the last sitting of the section on Wednesday, Prof. Debus gave a very interesting

paper on the chemical theory of fired gunpowder. The author deduced, from the analytical results published in Messrs. Noble and Abel's excellent researches on fired gunpowder, as well as from the analyses of the products of the combustion of powder published by Bunsen and Schischoff, the following general results concerning the products of combustion—(1) the sum of the potassium contained in the potassic hyposulphite, sulphate, and sulphide, stands to the potassium in the potassium carbonate approximately in simple proportions; (2) the carbon of the carbon oxide stands to the carbon of the potassic carbonate also approximately in a simple proportion. From this, as well as from the relation of the sum of the potassium contained in the sulphide and hyposulphite to the potassium in the sulphate, it is possible to form a theory for the combustion of powder. There are several reactions between the constituents of powder when the latter is fired. Two of these are simultaneous; the way in which the others succeed each other cannot be accurately determined. As first, when a portion of the carbon is burned, potassic carbonate, carbonic oxide, nitrogen, and carbonic acid are produced. Simultaneously with this reaction another takes place—a portion of the saltpetre and the whole or a portion of the sulphur form potassic sulphate and carbonic acid. The action of still unburnt carbon and of free sulphur on the potassic sulphate, in a succeeding stage of combustion, causes formation of potassic sulphide and hyposulphite.

Mr. T. E. Thorpe communicated a short note "On a Compound of Fluorine and Phosphorus." The new body was obtained by acting upon terfluoride of arsenic with pentachloride of phosphorus. The product is a gas which is stable at ordinary temperatures, can be kept over mercury, but is decomposed by water. The author believes it to be a condensable gas, and from an analysis shows that it is a pentafluoride of phosphorus.

Prof. Gladstone read a paper "On the Relation of the Arrangement of the Acids and Bases in a Mixture of Salts to the Original Manner of Combination." The question proposed in this paper is—supposing two salts, such as sulphate of potassium and nitrate of magnesium, are dissolved and mixed together in equivalent proportions, is the solution identical with a mixture of sulphate of magnesium and nitrate of potassium in equivalent proportions? Evidence of the point was sought principally in the action of the two mixtures on a highly-coloured salt, such as ferric sulphocyanide, bromide of gold, or potassium-iodide of platinum. According to the laws of reciprocal decomposition, every addition of a colourless salt ought to reduce the colour of these solutions, and every different salt will probably cause a different amount of reduction; nevertheless, in a series of experiments with various salts, it was always found that the coloured salt was equally diminished in colour in which ever way the acids and bases had been originally combined.

The same author had, in conjunction with Mr. A. Tribe, two notes "On the Action of the Copper Zinc Couple." The first of these showed that zinc, covered with a deposit of copper, is considerably more effective in the decomposition of water than pure zinc. The second note stated the interesting fact that no arseniuretted hydrogen is formed in the decomposition by the copper-zinc couple, though the zinc may contain arsenic. Another paper by the authors showed that the chemical activity of aluminium is augmented by its contact with more negative metals.

The rest of the communications were: "On the Nature of Vinylic Alcohol," by Dr. Armstrong; "On a New Process for the Separation of Lead, Silver, and Mercury," by Mr. T. J. Fairley; "On a Process for the Preparation of Periodates,

with their Application as a Test for Iodine and Sodium," by the same author; and "On an Apparatus for Examining Polluted Air," by Mr. W. Thomson.

Prof. A. W. Williamson, F.R.S., read the "Report of the Committee for the Purpose of Superintending the Publication by the Chemical Society of the Monthly Reports on the Progress of Chemistry." This Committee was composed of Dr. Frankland, Dr. Roscoe, and the Professor, who were intrusted with administering the grant of money the British Association had been good enough to give to the Chemical Society to aid in publishing the monthly reports of the progress of chemistry, a movement which was commenced five years ago. These abstracts supplied, he said, an important need for the advancement of this science. Dr. Russell having returned thanks on behalf of the Chemical Society, Mr. P. S. Evans, of the Avonside Tannery, Bristol, read a paper on "Tanning," subsequently re-delivered by him in Section F, in which he emphatically rejected the idea that any great reduction of time could be advantageously effected. In reply to a question by Dr. W. A. Tilden, Mr. Evans said that he did not know of any process for reducing the dark colour produced by using the extract of hemlock bark in tanning. Professor Williamson, in reply to a question, said the results obtained by the use of gallic acid in tanning were totally different from those obtained by the use of tannic acid. The President was of opinion that the time taken in tanning might be considerably reduced by chemists being consulted and employed in the process. Dr. J. Watts explained at some length Muntz and Rampacker's apparatus for the estimation of tannic acid. This hydrometer was, he said, very accurately and carefully graduated, and consequently would prove very serviceable to those engaged in tanning, for the purpose of analyzing tanning materials so as to test their leather-producing qualities.

Mr. P. Braham spoke of some further experiments he had made on the "Crystallization of Metals by Electricity." These experiments were performed by using a solution of zinc and copper sulphates, and crystallizing them by electricity between terminals of copper, zinc, and brass. With copper a dull crystallization commences which ultimately resolves itself into copper; with zinc, a dull crystallization which ultimately resolves into zinc; and with brass (a mixture of copper and zinc), a dull crystal, which, when it reaches the other terminal, glows with copper in a reverse direction.

Mr. J. W. Gatehouse followed with a paper, "On Nitrate of Silver," being an account of a series of experiments undertaken by the writer in consequence of having been applied to several times by photographers to investigate for them the reason of a certain deteriorating action termed by them "woolliness," to which they found their nitrate of silver sensitizing baths exposed. The speaker said that having noticed in several of these cases the presence of nitrate of silver in the bath, it appeared advisable to investigate the properties and mode of production of this silver salt more fully than had yet been done. Nitrate of silver was formed, he said, in brilliant yellow needle-shaped crystals, which darken on exposure to light. These are soluble in 1,058 times their own weight of cold and largely in boiling water. It is also soluble in ammonia, from which it crystallizes in fern-like crystals. It also dissolves with decomposition in nitric acid.

Mr. Thomas Farley, F.R.S.E., dwelt "On New Solvents for Gold, Silver, Platinum, &c., with explanation of so-called catalytic action of these Metals and their Salts on Hydrogen Dioxide," and subsequently spoke of "The Use of Potassium Dichromate in Grove's and Bunsen's Batteries, to insure constancy." In the former paper Mr.

Farley showed that many ordinary dilute acids with hydrogen dioxide (or oxygenated water) can dissolve the precious metals—gold, silver, and platinum. He also gave an interesting explanation of many chemical decompositions hitherto little understood, in which the element oxygen is given off, confirming the theory of the compound nature of ordinary molecules of the metals. In reference to the latter subject Mr. Farley said that by the use of potassium dichromate along with the nitric acid the evolution of noxious fumes is prevented, and the constancy of the battery maintained so long as the liquid contains an excess of the dichromate.

GEOLOGY.—An address on the geology of the neighbourhood of Bristol came with peculiar appropriateness from the president of this section, Dr. T. Wright, who has worked so long and so well at the rocks and the fossils of the West of England. Bristol is favourably situated for geological studies, and, as the President remarked, "there is probably no other place in England where, within so limited an area, typical examples of so many different formations occur, as around this city; for within a short distance by road or rail we may investigate the Silurian, Devonian, Carboniferous, Triassic, Liassic, Oolitic, and Cretaceous formations, all of which will yield many interesting species for the cabinet of the palaeontologist, and a valuable series of rocks and minerals for the student of physical geology."

Dr. Wright gave a general résumé of the structure of the district. In the concluding part of his address he dwelt upon the general deductions of palaeontologists as regards the succession of life upon the earth, and the conditions under which such life existed in successive periods. He said:—"As far as I have been able to read the records of the rocks, I confess I have failed to discover any linear series among the vast assemblage of extinct species which might form a basis and lend reliable biological support to such a theory." What the true explanation of the incoming of new forms of life may be was not stated, for, he said, "palaeontology affords no solution of the problem of creation, whether of kinds, of matter, or of species of life, beyond this, that although countless ages have rolled away since the denizens of the Silurian beach lived and moved, and had their being, the biological laws that governed their life, assigned them their position in the world's story, and limited their duration in time and space, are identical with those which are expressed in the morphology and distribution of the countless organisms which live on the earth's surface at the present time; and this fact realizes in a material form the truth and force of those assuring words, that the Great Author of all things, in these His works, is the same yesterday, to-day, and for ever."

The coal-measures of the Bristol area are of great importance. The subject was touched upon by Dr. Wright, but was more fully treated in an elaborate paper by Messrs. Cossham, Wethered, and Saisse.

Mr. J. M'Murtrie gave an account of some curious isolated masses of carboniferous limestone which occur at Luckington and Vobster. They are surrounded by coal-measures, except in one instance, where they are partly covered by Oolitic rocks. It has long been a curious problem how these masses of rock could attain their present position, and many suggestions have been made to account for the facts. Most of these explanations involve the assumption of several faults letting down the limestone amongst the coal-measures; but recent mining works have proved that these faults have no existence, and in some instances the coal-beds have been followed, without any break, quite beneath the limestone.

There has been some doubt as to the age

of the limestone at Cannington Park, but Mr. Tawney gave good reasons for believing it to be of carboniferous age. This decision is important, as it renders more probable the occurrence of coal-measures on the south side of the Mendips, and under the Somersetshire flats. One other communication relating to the carboniferous limestone was made by Mr. W. Stoddart, who announced the discovery of minute quantities of gold, with some silver, in the limestone of Clevedon.

Reports on explorations were read—by Mr. W. Pengelly, F.R.S., on Kent's Cave, Torquay, and by Mr. R. H. Tideman, M.A., F.G.S., on the Victoria Cave, Settle. The latter gentleman produced a bear's fibula discovered in the Victoria Cave, and attributed its malformation to fossilized rheumatism. Mr. H. Woodward (of the British Museum), the Rev. H. W. Crosskey, Professor Hull, Mr. Vivian, and Mr. L. C. Mial, F.G.S., entered into a discussion on bone caves, and the President, in summing up, said they had no direct evidence that man existed previous to the Glacial Period. Mr. Crosskey delivered the third report of the committee on Erratic Blocks in England and Wales, and complained that the boulders were used as foundations for churches, thus destroying evidences of the Glacial epoch.

Mr. E. B. Tawney, F.G.S., read a paper "On the Age of the Cannington-park (Bridgewater) Limestone and its Relation to the Coal Measures South of the Mendips." The author said there was a paucity of fossils, but he had found there at least one carboniferous species which had never been found in Devonian rocks, and this alone was considered to be a sufficient proof of its carboniferous age. Mr. W. W. Stoddart, F.G.S., described the unusual occurrence of the presence of gold and silver, which he had discovered in a sample of carboniferous limestone in a quarry at Walton, near Clevedon. He remarked upon the absence of sulphur and silica, which so often accompanied gold deposit. The quantity of the gold and silver present was exceedingly small. Professor Harkness summarised reports prepared by Professor A. H. Nicholson, D.Sc., F.G.S., and Mr. C. Lapworth, F.G.S., on some sections of the Silurian Rocks in the Lake district. Professor T. M. K. Hughes, M.A., F.G.S., gave some notes on the Classification of the Sedimentary Rocks, dividing them into the lower group up to the top of the old red sandstone and the upper group from the top of the old red sandstone to the recent. He advocated a reclassification of the series, but this was deprecated by Professors Harkness and Hull, the latter urging that the re-naming of the strata would simply throw the nomenclature of geology and allied sciences into a state of irretrievable confusion. Mr. H. Hicks followed with remarks on some areas where the Cambrian and Silurian rocks occurred as conformable series.

In this section, presided over by Dr. T. Wright, the main interest centred in a discussion arising out of a paper contributed by Professor Hébert, who argued that, in consequence of the number of anticlinal ridges running under the Channel, parallel with it and at right angles, it would be impossible to construct the tunnel under the Straits of Dover otherwise than in a circuitous direction. Sir John Hawkshaw, President of the Association, who happened to be present at the time, said that very likely from general reasoning Professor Hébert might safely arrive at the conclusions which he had placed before them, but he himself had taken means to ascertain as nearly as it was practicable at present what was the state of things in that portion of the Channel, and he did not think the result accorded with the intimation which Professor Hébert gave. The President went on to describe what had been done.

The first inquiry made was a geological one, by carefully measuring to ascertain on each

side of the Channel the outbreak of the beds which lay underneath as accurately as could be done by that process. Having done that and ascertained the thickness of the beds by levels, the results were laid down in the geological map. Of course, that was not sufficient to satisfy him, because in a work of that sort they must have more accurate information. It appeared from the geological map that a line between St. Margaret's Bay and Sangatte would be suitable to carry the tunnel through the lower chalk, and to verify this an examination was made across the Channel by dropping from a steamer a weighted instrument in 500 places, the apparatus running with great velocity to the bottom and bringing up chalk where they expected. That was so far in corroboration of what had been done before, and if it were necessary in constructing the tunnel to follow such a circuitous line as Professor Hébert had pointed out, it would never be constructed at all—only in a straight line. People found that the tunnel would be near the water, and thought that any small error would affect its construction; but the deepest point of the Channel in that part was 180ft., and it was proposed to take the tunnel about 230ft. or 240ft. below the bottom. Having had to tunnel below the sea, he knew the difficulties which must be encountered. The current was so strong there that the bottom was washed quite clean, and their experiments showed the absence of any deposit. As to the question of ventilation, it was continually assumed that they would construct a tunnel into which nobody would dare to go. A great difficulty would be the conveyance to and fro of the men and material, but this might be provided for by introducing pneumatic tubes on each side of the Channel; and assuming the tunnel to be made, the only necessity was to exhaust the air from the tube by an aperture in the centre of the tunnel. The ventilation would be quite easy. He had been silent about it, because engineers did not usually speak of works until they were executed, and did not care to talk about them; but when the tunnel was accomplished, the way in which it had been made would be patent to everybody. Of course, in many of these things they were obliged to return the Scotch verdict "not proven;" but it was sufficiently conclusive to his mind to induce him to enter upon the work.

A report on the sub-Wealden explorations represented that, as after three years they had not found palæozoic rocks at a depth of 1,790ft., and had been seriously impeded by Kimmeridge clay, it was not intended to resume the boring at present. The other papers were by Mr. D. Mackintosh, on polished stones of Cefn Cave, and advocating the substitution of the term "drainage area" for "river basin;" also by Mr. J. R. Mortimer, on the distribution of flint in Yorkshire; and by Professor Hull on diatom in coal.

Dr. W. Carpenter made some remarks on the origin of the red clay found by the Challenger at great depths in the ocean. He had no reason to believe that any ash was left behind when the foraminiferal shells had been dissolved in dilute acid; he thought they would give as pure a carbonate of lime combined with animal matter as they could get anywhere. Another source which occurred to him was that the red clay was the result of disintegration of the internal casts, the green or ochreous having been acted upon by carbonic acid. Sir J. Hawkshaw, who was present, said that last year, during the meeting of this Association at Belfast, he was passing along the coast of Brazil, and what struck him as one of the most remarkable features was the enormous mass of red clay along the coast for a couple of thousand miles. It was some thousands of feet thick, and uniformly the same colour—very much the colour of hematite iron ore—deep red. The clay was so remarkably

compact that it formed mountains, and at a distance they would suppose it was one of the hardest rocks, but they could cut it with a sharp tool. That clay must extend 4,000 or 5,000 miles, and if these investigations in which Dr. Carpenter had taken so much interest should throw any light upon this enormous mass of clay, it would be a most interesting result.

Mr. H. Woodward, of the British Museum, presented a tenth report on British fossil crustacea, and mentioned the discovery of a scorpion in coal measures near Birmingham, and a new orthopterous insect in English coal measures. Papers were also contributed by Mr. W. Sanders, F.R.S., on the large bones in Rhætic beds at Aust Cliff; by the Rev. P. B. Brodie and Mr. W. J. Harrison on the further extension of the Rhætic or Penarth beds in the Midland and Northern counties, mentioning the occurrence of some supposed remains of a Labyrinthodon and a new Radiate in those beds; by the President on the Reptilian remains from the Dolomitic conglomerate on Durdham Down; by Mr. J. Hopkinson on the distribution of the Graptolites in the lower Ludlow rocks; by Professor H. A. Nicholson and Mr. C. Lapworth on a new genus of Graptolites from the Skiddaw slates; and by Mr. W. H. Baily on a new species of Labyrinthodon Amphibia from Jarrow Colliery, Kilkenny.

ANATOMY AND PHYSIOLOGY.—Dr. P. L. Selater, President of the Biological Section, delivered his introductory address in the Department of Zoology and Botany. The work of the department commenced with the "Report of the Committee appointed at Bradford in 1873 to investigate the Physiological Action of Light," read by Dr. M'Kendrick. The labours of the committee, which consisted of Prof. Balfour, Prof. Dewar, and Dr. M'Kendrick, had extended over three years, and had resulted in conclusions of the highest interest and importance. (1.) The impact of light on the eyes of mammalia, birds, reptiles, amphibians, fishes, and crustaceans, produces a variation amounting to from three to ten per cent. of the normal electro-motive force existing between the surface of the cornea and the transverse section of the optic nerve. (2.) This electrical variation may be traced into the brain. (3.) Those rays that are regarded as most luminous produce the largest variation. (4.) The electrical alteration is due to the action of light on the retinal structure itself, as it is independent of the anterior portion, eliminating, therefore, the natural supposition that the contraction of the iris might produce a similar result. (5.) It is possible by experiment to discover the physical expression of what is called in physiological language "fatigue." (6.) The method employed in this research may be applied to the investigation of the special organs of the other senses. The difficulty due to the constantly diminishing sensibility of the retina when the eye was separated from the body and deprived of blood was overcome by experimenting on living animals under the influence of woorara or hydrochlorate of chinoline (a new anæsthetic which we owe to Dr. M'Kendrick and Prof. Dewar's researches on another committee). On applying the electrodes of a galvanometer to the cornea and to the surface of the skin, large deflections were obtained, sensitive to light and showing a remarkably constant alteration. The initial effect of light sometimes produced an increase, sometimes a diminution, of the natural current. A great number of experiments showed that this depended on the primary direction of the natural current, e.g., if the cornea be positive to the surface of the brain the initial effect of light is an increase, but if some part of the brain be positive to the cornea, the initial action is a diminution of the natural current. The explanation is that the current induced by light has a constant

direction, but that the deflection of the galvanometer is, in the one case, the expression of the *sum*, in the other, of the *difference* between the natural and the induced currents. The action of polarized light and of rays of various refrangibility was investigated. Yellow rays were found most potent, whereas the extreme red and extreme violet rays were without effect. The electro-motive force of the living eye was determined by Mr. Latimer Clarke's comparative method. One Daniell cell was found too powerful, and hence they made use of a thermo-electric couple, which gives constant results, and the electro-motive force of which in respect to a Daniell cell was determined. By this means the electro-motive force of the eye of a frog was found to be 1-350th part of a Daniell cell, that of a muscle of a frog being 1-35th, that of nerve 1-480th. Lastly, experiments were made by a Regnault's chronograph to determine the time taken by light to effect a change in the electrical relations of the frog's eye. Making allowance for the personal equation of the observers, this was found to be about 1-10th of a second, thus agreeing in a remarkable manner with the conclusions arrived at by Prof. Donders, of Utrecht, and since confirmed by other physiologists, as to the time occupied by the action of light on the human eye. The result of this investigation shows that the electrical variation observed in the action of light is what occurs in the eyes of all members of the animal kingdom.

The absence of a discussion after the reading of this remarkable report, says the *Athenæum*, whose aid we have resorted to in some of the present reports, must be attributed in great part to the impossibility of finding any point to attack in the reasoning of its authors; but we cannot help thinking that it was also greatly due to the much commented on absence of physiologists from the meeting, neither Prof. Rutherford, Dr. Michael Forster, Dr. Burdon Sanderson, nor Mr. Ray Lankester being present. Indeed, in no section were the President and committee so feebly supported.

Mr. H. B. Brady exhibited some excellent micro-photographs of physiological and pathological preparations taken by Mr. Hugh T. Bowman, of Newcastle, a tyro in both microscopy and photography. The apparatus was also shown and described. It consisted of a simple mirror of speculum metal, placed at an angle of forty-five degrees in front of the eye-piece of the microscope, and directed downwards. The image was received upon a collodion plate set in the frame of a common photographic camera, and the photograph taken in the usual way.

The President, while admitting the utility of the invention, said that some difficulty would arise in its practical application.

A paper, by Messrs. L. C. Miall and F. Greenwood, "On Vascular Plexuses in the Elephant and some other Animals," followed. Vascular plexuses, which it seems are very abundant in the elephant, were divided into Arterial and Venous, and each of these again in Funiform and Retiform. Their physiological significance was much discussed, the authors being of opinion that in the elephant they were connected with absorption and nutrition, and were correlated with the remarkably deficient development of the lymphatic system in that animal.

Concerning Dr. J. Goodman's paper, "On Protoplasm and Adipocere," the less said the better.

Mr. C. O. Groom Napier then read a paper, "On Vegetarianism a Cure for Intemperance." He said Liebig, in his "Animal Chemistry," had stated twenty years ago that the use of cod liver oil caused a disinclination for drinking wine, and that most people found they could take wine with animal food but not with farinaceous food.

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PROCEEDINGS OF INSTITUTE.—No Meetings have taken place since our last issue.

STORAGE OF EXPLOSIVES.

At a time like the present, when every effort is being made to reduce the danger attending the storage and transport of explosives to a *minimum*, any invention claiming with reason to fulfil that object is worthy of notice. Such an invention is the fire and damp-resisting magazine of Deputy-Commissary W. H. Chambers, of her Majesty's Control Department, Woolwich. The magazine is cylindrical or drum-shaped in form, and can be made of any required size, so as to conform to the exigencies of transport, and, at the same time, to be useful in storage. It consists of an outer casing of galvanised sheet iron, pierced with several small holes, through which any moisture or steam may escape from the body of the magazine when subjected to great heat, the holes being plugged with red lead. Next comes a lining of plaster of Paris in a concrete state 1 in. thick, and coated on its interior surface with a thin layer of Portland cement. Inside this, again, is a 1½-inch thickness of plaster of Paris in powder and well pressed down. An intermediate casing of thin sheet iron, galvanised, comes next, within which is a 1-inch thickness of ground cork; and, finally, an inner lining of sheet zinc. This forms the sides and bottom of the magazine, the lid being similarly constructed and either screwed bodily into the mouth of the drum, so as to be easily removable, or hinged to it. In either case the lid is provided with proper fastenings, and the meeting edges of the lid and body are hermetically sealed. The portable magazines measure about 32 in. in height, with a diameter of 28 in., outside measurement, being but little larger than the portable magazines at present in use. The effect of this method of construction is to obtain a very low conducting power—so low that, on exposing a magazine to the heat of a fire sufficiently fierce to bring the outer casing to a welding heat, the temperature in the interior is only raised to from 214deg. to 219deg. Fahrenheit. Another result is that, while practically fireproof, the magazine is also damp-proof. On exposing the magazine to heat, the contained powder remains uninjured, instead of being spoilt, as in some cases it is, by the vaporization of chemicals with the object of rendering the contents inexplusive. Before patenting his invention, Mr. Chambers took the precaution to test his system. The tests were made by Messrs Miller and Herbert, engineers, of Heriotsfield Works, Edinburgh, with highly satisfactory results, but want of space compels us to reserve a full exposition of this invention till another occasion.

Monthly Notices.

Mr. R. A. Proctor sails for the United States on the second of next month, on a lecturing expedition.

The Aeronautical Society of Great Britain has issued its Ninth Annual Report for 1874. It contains papers on the conditions required for flight. It does not seem that success has attended any form of apparatus yet designed for the purposes of flight.

At the British Association, at Bristol, following the plan initiated last year, a temporary Museum was established for the reception of specimens illustrating papers read before the Sections. This Museum was placed under the charge of Mr. J. E. Taylor, the Curator of the Ipswich Museum.

Sir Robert Christison has been nominated President-elect of the Glasgow meeting next year. In 1877 the Association will visit Plymouth.

The Academy of Sciences of Paris, at the *séance* of the 23rd August, named two commissioners for the revision of the *Comptes de l'Académie* during the current session, to replace M. Mathieu, deceased, and M. Brongniart, who has retired. M. l'Amiral Paris and M. Chevreul were elected.

Messrs. Macmillan and Co. will publish in the autumn, under the title of "The Modern Telescope," a series of lectures delivered at the Royal Institution by Mr. J. W. Lockyer, with notes and additions by Mr. G. M. Seabroke. The volume will be uniform with "Solar Physics," by the same author.

Mrs. Herschel, wife of Capt. Herschel, F.R.S. (grandson of the celebrated Sir William Herschel), is now engaged on a memoir of Miss Caroline Herschel, the accomplished sister and assistant of Sir William, compiled from her own journals. Several letters of the great astronomer, hitherto unpublished, will be included in the volume.

The Philosophical Magazine contains Mr. Croll's paper in full, "On the Challenger's Crucial Test of the Wind and Gravitation Theories of Oceanic Circulation, read before the British Association.

A Subterranean forest, below the Thames, near Cherry Garden pier, has been reported to be discovered. The oak, the alder, and the willow are the principal trees. These retain their vegetable character, but other evidences show that the forest belongs to the period of the elk and the red deer of the South of England.

Foreigners present at the Bristol meeting: M. Charles Buis, of Brussels; M. C. Bergeron, of Paris; Prof. Hébert, of the Sorbonne; Dr. J. Janssen, of Paris; Dr. Nachtigall, of Berlin; Dr. Oppenheim, of Berlin; and Prof. Vanderkindere, of Brussels. America was represented by Col. Carrington, Dr. Paterson, Mr. H. A. Rowland, Mr. J. J. Skinner, Prof. Summers, and Dr. Youmans.

The Sub-Wealden Exploration is drawing towards a close. A depth of 1,750 feet has been reached, and the last cores drawn to the surface show abundant remains of Lingula, Thracia, and Ammonites, which have hitherto been supposed to denote the Kimmeridge era. The probability, therefore, is that this boring will only prove that a great thickness of Kimmeridge clay exists in Sussex.

Messrs. H. S. King and Co. promise the following scientific publications, four new volumes of the International Scientific Series:—"Animal Parasites and Messmates," by M. Van Beneden, Professor at the University of Louvain; "The Nature of Light," with a general account of physical optics, by Dr. Eugene Lommel, Professor of Physics in the University of Erlangen; "The Five Senses of Man," by Prof. Bernstein, of the University of Halle; and "Fermentations," by Prof. Schutzenberger, Director of the Chemical Laboratory at the Sorbonne; and also a work by Mr. R. A. Proctor, dealing with life in other worlds, entitled "Our Place in the Universe."

Mr. Kegan Paul's "Life of William Godwin" is at last to appear. As has been already announced, the book will contain letters, hitherto unpublished, by Shelley, Lamb, Coleridge, Mrs. Shelley, Godwin himself, Mary Woolstonecraft, and others. Not the least interesting of the relics preserved is a diary of William Godwin, carefully kept by him through the whole of his career. In the middle and latter part of his life not a day is passed by without some record. Godwin, at one time, meditated writing an autobiography, but did not proceed far with it. The fragments of it are in Mr. Paul's hands. Mr. Paul intends, after the publication of the "Life of Godwin," to make still further use of his materials.

THE BRITISH ASSOCIATION.

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Struck by this and his own experience as a vegetarian, he had tried a vegetarian diet as a cure for intemperance in twenty-four refractory cases, always with the same result, viz., loss of desire for alcoholic drinks in from four weeks to twelve months. He stated that macaroni, haricot beans, peas, and highly glutinous bread were especially antagonistic to alcohol, and then alluded to the immense national economy that would be effected by growing wheat where now barley is grown.

Though Mr. Napier may have overstated his case in his enthusiasm, Mr. Bigg was not therefore justified in appealing to comparative anatomy as an argument against vegetarianism, apparently forgetting that the dentition and alimentary canal of man are far more like those of the higher apes (which are frugivorous) than those of any other animals. The President with more force said that the Scotch were not, as a class, intemperate; but, though living on oatmeal, they were also fond of another farinaceous food going by the classical name of the "barley bree," and the mixture did not seem to be very injurious. After Mr. Napier's reply the department adjourned.

On Friday the department met after the delivery of Prof. Rolleston's Introductory Address to the Anthropological Department.

The "Second Report of the Committee on Intestinal Secretion," by Dr. Lauder Brunton and Dr. Pye Smith, was presented. The first report had dealt chiefly with the chemistry of the secretion; this was directed to the influence of the nervous system on the secretion. The experimental results, which were mainly negative, were considered to prove the absence of influence on intestinal secretion through the splanchnic nerves, the pneumogastrics, the sympathetic above the diaphragm or the spinal marrow; and the probable influence of the ganglia continued in the solar plexus, though certainly not of the two semilunar ganglia exclusively. Also the independent occurrence of hæmorrhage and of paralytic secretion appeared, in the view of the committee, to point to a separate nervous influence on the blood-vessels and the secreting structures of the intestines.

The committee fully acknowledged that their results were not uniform, but believed this might be explained by anatomical difficulties in the animals employed. On account of the importance of the subject in its bearing on the action of purgative medicines, as well as on physiology generally, the committee was re-appointed.

A paper by Dr. George and Dr. Frances Elizabeth Hoggan, "On the Origin of the Lymphatics," followed. Numerous camera lucida drawings of microscopic preparations were shown, and the authors claimed to have discovered the "ultimate radicles" of the lymphatics in certain branched "lymphatic cells."

Dr. Martyn's paper, "On some new Researches on the Anatomy of Skin," dealt with the *rete mucosum* or deeper portion of the epithelial layer, and especially with the cells called by Max Schultze "prickle cells." Dr. Martyn, by the use of very thin sections and a high power of the microscope (1-12th inch), believed that he had proved that the cells in which this appearance is seen are in nature connected together by numerous bands, which, when ruptured by separation of the cells, caused the appearance of prickles. For this structure, which he had observed in cancer, in healthy human skin of the heel, in the front of the eye of the pig, and in the lips of a fish, he proposed the name of "Conjoined Epithelium." The genesis of these bands he explained by supposing the process of fission to be checked before the cells were completely separated. He attributed a similar origin to all branched cells, and combated the

theory that cells have a power to throw out arms permeating other tissues, thus attributing the shape of such cells to ordinary forces, and not to any mysterious vital power of the cells themselves.

A highly suggestive paper was read by Dr. J. G. McKendrick and Prof. Dewar, "On Further Researches on the Physiological Action of the Chinoline and Pyridine Bases."

ANTHROPOLOGY.—Dr. Rolleston, F.R.S., F.S.A., Linacre Professor of Anatomy and Physiology, Oxford, President of the department, delivered the address.

Mr. C. O. Groom Napier, F.G.S., read a paper "On the Localities Whence the Tin and Gold of the Ancients were Derived," and then followed a group of papers on kindred subjects—viz.: "On the Original Localities of the Races forming the Present Population of India," by Sir Walter Elliott, K.C.S.I.; "On the Himalayan Origin of the Magyar and Fin Languages," by Mr. Hyde Clark; and "The Weddas of Ceylon," by Mr. Bertram F. Hartshorne. The account given by the latter gentleman, who belongs to the Bengal Civil Service, of his personal observation of the habits and physiology of the Weddas was very interesting; and led to an animated discussion. He said they were a remarkable race of aborigines, who still depended for their means of subsistence upon their bows and arrows, and passed their lives in the vast forests of Ceylon without any dwelling-houses or system of cultivation. There was an entire absence of any flint or stone implements among them, and their state of barbarism was indicated by the practice of producing fire by means of rubbing two sticks together, as well as by their habitual disregard of any sort of ablution. Their intellectual capacity was very slight; they were quite unable to count or to discriminate between colours; but while their moral notions led them to regard theft or lying as an inconceivable wrong, they were devoid of any sentiment of religion, except in so far as that might be inferred from their practice of offering a sacrifice to the spirit of one of their fellows immediately after his decease, their idea of a future state being that they became devils after death. They never laughed, and it was observable that they were the only savage race in existence speaking an Aryan language. Dr. Leitner, of Lahore, gave a vivid description of an ethnological and linguistic tour of discovery which he made through Dardistan, the chief result being to establish the existence of languages contemporaneous with the Sanscrit; and the Rev. Wyatt Gill read a paper "On the Traditions of the Hervey Islanders."

Mr. Pengelly, F.G.S., gave an interesting account of excavations made during the last twenty years in "Kent's Cavern," an ancient cave near Torquay, on the coast of South Devonshire. The discoveries comprised human remains, bones of the hyæna and other animals now extinct in this country, and domestic articles, evidently made and used by rude races of savages. The results of the excavations clearly pointed, in Mr. Pengelly's opinion, to the greater antiquity of man than the popular belief assigned to him. After a brief discussion the President said he thought it impossible to escape the conclusions arrived at by the reader of the paper.

"Rhabdomancy and Belomancy" was the title of an interesting paper contributed to the department by a lady, Miss A. W. Buckland, of Bath. In some of the out-of-the-way mining districts in the Mendips, not far from where the anthropologists were then assembled, the dowsing-rod still holds its place, and rhabdomancy has, therefore, not entirely died out in this country. The arts of magic and divination may, perhaps, be regarded as surviving relics of a pre-Aryan or Turanian faith, which had once a very wide distribution; and Miss Buckland suggested that

rhabdomancy might be useful as a racial test. If this be so, those of our western mining population who believe that they possess power in the divining-rod may, perhaps, be brought into remote affinity with the aboriginal inhabitants of these islands.

Extensive excavations have recently been made by Col. Lane Fox at Cissbury Camp, north of Worthing, a site well known to archaeologists, especially through the Colonel's former investigations. Numerous worked flints, remarkable for presenting forms intermediate between the palæolithic and neolithic types, have been found at this locality, where it is believed a flint-implement factory must have existed. Shafts had been sunk through the solid chalk, and galleries driven along a seam of flint, which was worked as the raw material of these implements. The main object of the recent excavations had been to determine the relative age of the pits and the entrenchment, and the result has clearly shown that the pits are by far the older. During the work, the skeleton of an ancient British lady was discovered, and Prof. Rolleston described this, and other organic remains, in a paper supplementary to Col. Lane Fox's communication.

Indian ethnology was by no means neglected at Bristol. Sir Walter Elliot, at the President's request, prepared a paper in which he discussed with much ability the origin of the races which enter into formation of the present population of India. It is generally assumed that Central Asia was the source whence the earliest inhabitants of India were derived, and it is probable that remnants of these primitive peoples are to be still found among the despised and degraded inhabitants of the hills and forests. Sir Walter maintained that the Dravidians presented the characters which Prof. Huxley assigned to his Australoid type.

Prof. Newton read a paper "On Certain Neglected Subjects of Ornithological Investigation."

A Report on Dredging off the Coast of Durham and North Yorkshire, by Messrs. David Robertson and G. S. Brady, described large additions to the Fauna. While the testaceous mollusca showed distinctly boreal characters, in the ostracoda and foraminifera this was by no means so apparent. It was not supposed by the authors that a cold arctic current was the only or chief agent in the continued existence of this peculiar Northumbrian molluscan fauna; they looked to more local circumstances.

A Report on Dr. Dohrn's Zoological Station at Naples described the manner of its working very fully. The work facilitated by the station is of the following kinds:—Morphology and embryology of marine animals; physiology and study of habits of marine animals; systematic investigation of the marine Fauna and Flora in the neighbourhood of Naples; physical investigation of the sea near Naples; experiments on breeding and preserving delicate marine organisms in a healthy condition; and transmission of specimens to investigators at home. The scientific work done at the station has already been most valuable; many leading biologists have spent considerable periods there. Dr. Dohrn intends to publish annual accounts of the work done at the station. It was much to be desired that governments, universities, and public institutions should support the station.—Mr. Spence Bate on this report remarked that we ought not to have to go to Naples for such opportunities; similar stations ought to be attached to every aquarium now established in England.

Dr. C. T. Hudson read an elaborate paper "On the Structure and Affinities of the Rotifera," to which he has devoted many years' careful study, as evidenced by the numerous beautiful diagrams he exhibited, and the new and important forms he has described. He conclusively showed

the fallacies of Ehrenberg's, Dujardin's, and Leydig's systems of classification, while giving them credit for their advantages. He proposed a new classification, which, while specially based on habits, was supported by general community of structure in the forms placed together. He divided them into—1, Rhizota, attached forms; 2, Bdelloida, those which swim and creep like a leech; 3, Ploima, free swimmers; and 4, Scirtopoda, jumpers. He arranged the families under these divisions. With the exception of the Philodines, he was inclined to refer Rotifers to the Entomostraca, for reasons which Mr. Spence Bate subsequently said absolutely convinced him of the contrary.

The botanical contributions to the earlier sittings related to discoveries of rare plants in Scotland, and to various abnormalities in flowers, and were not of wide interest.

DEPARTMENT OF ZOOLOGY AND BOTANY. In this department, Mr. H. E. Dresser, F.Z.S., gave the report of the committee for the purpose of considering the desirability of establishing a close time for the protection of indigenous animals; and Mr. C. Spence Bate, F.R.S., the report on the present state of our knowledge of crustacea (Part I., on the homologues of the dermal skeleton); and papers by Dr. Carpenter, Mr. D. A. Spalding, and Professor Williamson, of no general interest, were read.

Mr. W. J. Cooper read a paper on "Some physiological Effects of Various Drinking-Waters." He gave the result of experiments with artificial drinking-waters on rats and other animals. He mentioned cases where horses had been poisoned by inorganic matter held in water, and discussed the effect of such water on human beings. It is known that goitre and other throat and glandular affections and even idiocy have been attributed to inorganic salts in drinking-water. We know that the human system is easily deranged by a change in the drinking-water. The spa and chalybeate waters at the favourite places of resort have been renowned for ages for their medicinal virtues. If the entire organic structures of the human body are liable to alteration when excess of mineral matter is introduced into the system, it is essential that health seekers at these medicinal springs should place themselves under medical supervision. And one of the first considerations in the inauguration of a water supply should be to insure a perfect freedom from excess of any mineral except those comparatively harmless ingredients—chloride of sodium and carbonate of lime.

Dr. Cornish, of India, Dr. Pye-Smith, Dr. Child, Professor Cleland, and others took part in the discussion upon the paper.

Dr. Hallett, of Bristol, read a paper on "The Bearings of the Conservation of Force on Life." This doctrine, known also as that of the co-relation of forces, has been fairly established by philosophers as applied to the convertibility of material as opposed to vital forces—that is to say, it seems established that motion, light, heat, electricity, chymical, and molecular forces are inter-convertible; in fact, are all forms of motion or energy, the aggregate amount of which is constant. More recently it has been conjectured that this doctrine might even be extended to vital phenomena, and some remarks of Professor Tyndal, in his address at Belfast last year on this subject, have, it may be remembered, stimulated the controversy. Dr. Hallett now, in an elaborate essay, opposed the idea of application of the doctrine to vital phenomena. He suggested that if his views were correct the tendencies to destruction of universe by the ultimate conversion of all forces into a dead level of heat, inevitable under the theory of his opponents, might be counteracted, and conservation of force exist in a higher sense.

Dr. Child, Dr. Martyn, the President, and Professor Allan Thomson, took part in the discussion which followed.

A paper by Mr. F. Greenwood, "On a Method of Preserving Large Animals for Anatomical Examination," brought the proceedings of this Department of the Section to a close for the present meeting of the Association.

Colonel Lane Fox, P.A.I., having temporarily taken the chair, Professor Rolleston read a paper the main purpose of which was to point out the danger of drawing conclusions touching ethnological subjects from isolated expressions in the works of poets and historians, whose liability to error might be judged of from the frequent inaccuracy of modern writers, the misuse of the term Briton of George I., Junius, and Tennyson being quoted as an instance.

The next subject brought before the Department was one which led to a lively passage of arms between Canon Rawlinson and Mr. J. A. Freeman, M.A. The former, in a paper on the Ethnography on the Cimbri, had set aside the authority of Julius Caesar and Tacitus in favour of the German origin of that ancient race, and preferred to believe in their affinity to the Celts. This elicited from Mr. Freeman, who repudiated the idea that he was a scientific man, a warm eulogy of the historians in question, and a vehement condemnation of those who ventured to ignore their authority. The two speakers who followed Mr. Freeman, however—viz., Dr. Beddoe, F.R.S., and the Rev. J. Earle, M.A.—supported the conclusions of the reader of the paper. Mr. Earle's interesting discourse "On the Ethnography of Scotland" brought the sitting to a close.

GEOGRAPHY.—Colonel T. E. Gordon read a paper "On the Exploration of the Pamir Steppe in Central Asia," which elicited some comments from the President, Sir Rutherford Alcock, Sir Henry Rawlinson, Colonel Montgomery, and others, all of whom concurred in pronouncing the paper to be a valuable contribution both to the cultivation of geographical science and the peaceful arts of commerce.

Sir Henry Rawlinson gave an outline of an elaborate paper on the Turcoman frontier of Persia, by Captain the Hon. G. Napier, son of Lord Napier of Magdala. Sir Henry described the discovery of the old bed of the Oxus as one of the most important which had been made in the present day.

Mr. Bates, secretary, read a paper by Major Herbert Wood, R.E., on the probable cause of the change of direction which has occurred in the corner of the Oxus from the Caspian to the Aral. This change of direction, in the opinion of the writer, was to be attributed to the abstraction of the waters of the Oxus for the purposes of irrigation, which has been practised from time immemorial. The writer was permitted by the Russian Government to accompany their expedition up the Aral, and his paper was founded on observations so made.

In the discussion which ensued, Professor Rawlinson spoke of the probability of the city of Merv playing an important part in the future history of the world, and pointed out that it had already in ancient times held a high position. Colonel Montgomery, Mr. E. D. Morgan, and the President also offered a few observations on the subjects treated in the papers of Captain Napier and Major Wood, and a vote of thanks was passed to the writers.

General Sir Arthur Cotton contributed a paper on the North-West African Expedition, in which he referred to what had been already accomplished as the fruit of the wonderful patience and energy of Livingstone. "There were," he said, "thirteen or fourteen expeditions from five or six civilised nations now engaged in Africa, from whose labours he anticipated the greatest benefits, both in civilising and Christianising the inhabitants of that continent."

Mr. Galton questioned some of the conclusions arrived at by the writer of the paper. He denied that Timbuctoo was an important

city, and he doubted the feasibility, in an engineering point of view, of flooding the Sahara and so bringing Timbuctoo within eight or nine days of England.

The Rev. Canon Tristram, Colonel Playfair, Professor Hennessey, Dr. J. C. Brown, and Dr. Nachtigal having spoken, most of them in depreciation of the scheme,

Sir Arthur Cotton made a few remarks in reply.

Sir H. Rawlinson, who was sitting as President of the section, while he thought it was not fair or common sense to "pooh-pooh" the subject, said it was not at present in a state to admit of geographical or scientific discussion.

The President and Sir H. W. Rawlinson having offered a few remarks, a vote of thanks was passed to Dr. Nachtigal for his paper.

Mr. Bates, secretary, read a paper by Lieut. W. H. Chippendall, R.E., describing a journey, beyond the Cataracts of the Upper Nile towards Lake Albert Nyanza. The party left Duffite, a Government station in lat. 3° 30', about seven miles above the Cataracts of the White Nile, on 26th of February, 1875, and pursued their journey as far as the village of Fashora, when, finding the country to be afflicted with small-pox, they determined to return without visiting the lake.

A paper read by Major Herbert Wood "On a Probable Cause of the Change of Direction which has occurred in the Course of the Oxus, from the Caspian to the Aral," related to the most recent change in the lower courses of the river, namely, that which is known to have happened in the years immediately preceding 1595, by which the bed now being surveyed by the Russians was forsaken, and the present embouchure into the Aral effected.

A paper was read by General Sir Arthur Cotton "On the Project for Letting the Waters of the Atlantic into the El Juf Depression of the Western Sahara."

A communication followed from Lieut. Chippendall, R.E., one of the English officers now engaged under Col. Gordon in exploring the lake regions of Central Africa which adjoin the newly-acquired Egyptian provinces. The paper narrated the chief incidents of a journey towards the outlet of the White Nile from Albert Nyanza, preliminary to the launching of a steamer on the lake.

Col. R. L. Playfair (H.M. Consul-General in Algeria) read a paper "On an Exploration of the Aurès Mountains in Algeria."

A paper, by General H. B. Carrington, U.S.A., giving a descriptive sketch of the territory of Dacotah, in North America, and one by Dr. J. C. Brown, "On the Physical Geography, Products, and Prospects of the South African Colonies," concluded the day's work.

On Tuesday morning, August 31st, a crowded audience assembled to hear the report of Mr. C. R. Markham, "On the Progress of the Arctic Expedition," which had been received only the previous evening from Plymouth, at which port the Valorous had arrived on Sunday, August 29th, from Greenland. After a long and stormy passage, the Alert and Discovery arrived at Godhavn, at the south-west end of the island of Disco, on July 6th, the Valorous having preceded them by two days. The embarkation of sledge-dogs, transhipment of coals and supplies from the Valorous to the expeditionary ships, and various scientific work, occupied ten days, and the two ships, en route to the Pole, were last seen in the evening of the 17th, making their way amidst icebergs through the Waigat, or the passage between Disco Island and the mainland. The last hours with the Expedition were thus described in the report:—"On Thursday, July 15th, at 4.45 p.m., the Expedition left Godhavn, the Alert towing the Discovery, and the Valorous following. The crew's-nests were in their places, and the boats (no longer on the skids, as when crossing the

Atlantic) were all hoisted up to davits. The surface of Disco Bay was like glass, and was all dotted over with icebergs of great size and most fantastic shapes, while to the north rose the basaltic cliffs forming the south shore of Disco, resting on the yellow sandstones of the Miocene period, which contain coal. At midnight on the 15th the Alert passed close under the landward face of a magnificent iceberg, a cliff of dazzling white, the top covered with gulls, which flew up in a great cloud. On the other side, the berg rose to a peak 200 feet high, under which there was a grand arch, the inner sides being of a deep, rich blue. The sea was as smooth as glass, and the sky, seen through the arch, was crimson tinged with gold. As we gazed upon this scene of wondrous beauty, the Valorous hove in sight through the arch, her dark hull and tall masts standing out against the sky. In another hour there was a dense fog, which cleared away towards morning, disclosing a fine panoramic view, with smooth sea and cloudless sky. On the left were the high basaltic rocks of Disco, with the opening of the Waigat full of icebergs, ahead the lofty mountains of the Noursoak peninsula, and to the right the gneiss cliffs and precipices of Arve Prins Island. . . . The Valorous was to sail at 4 the next morning, and proceeded to a place on the Disco shore of the Waigat to dig for coal, and the discovery ships were to follow them two hours later. The 16th of July was, therefore, the last day on which the gallant explorers would see any of their countrymen, and here I took leave of them. The Valorous sailed from Ritenbenk at 4 a.m. on July 17th, the Alert and Discovery following at 6. At 1 p.m., the Valorous anchored off the coal-bearing cliffs on the Disco side of the Waigat. From the hills above these cliffs there is a magnificent view of icebergs streaming out of the Fossakatek fjord, at the head of which there is a great discharging glacier, and amongst them the Arctic ships could once more be seen under all plain sail, over on the Greenland side of the strait. They were standing down the Waigat (the Alert leading), appearing and disappearing behind the high icebergs. At 5 p.m. the Valorous hoisted a signal at all three mastheads, "Farewell! Speedy return!" It was not seen for a long time, but at last the Discovery hoisted "Thank you," and afterwards the Alert ran up the affirmative pendant. They continued to stand on, and were just about to disappear behind a point of Disco Island, when, at 6.15 p.m., the Alert hoisted a signal to the Discovery,—"Do you wish to communicate?" A few minutes afterwards the Alert went about, apparently intending to beat up to windward and communicate with the Valorous; and at 6.30 p.m. she hoisted a second signal to the Discovery,—"Optional, beat to windward," we thought it was. Then a fog suddenly sank down on the water and hid both ships from sight. This is the last that was seen of the Arctic Expedition.

Mr. Keith Johnstone, who visited Paraguay in 1874 as a member of a Scientific Commission engaged by the Paraguayan Government, gave the section an account of the two journeys he was enabled to make across the country, notwithstanding the dissolution of the commission soon after its arrival in Asuncion.

Under the title of "The Glaciers of the Western Himalaya," Lieut.-Col. T. G. Montgomerie, R.E., of the Indian Trigonometrical Survey, gave a full description of the gigantic glacier system of the Himalayan range, which reaches its greatest development in Baltistan, in North-western India. The paper was illustrated by a number of superb maps and pictorial views of glacier scenery. The glaciers gradually increase in size from east to west, and in the Mustagh range are in many cases more than twenty miles in length, the largest being the Biafo, thirty-four miles in length. The thickness of the ice was in some cases found to be 400 feet. The result of experiments showed that the general

phenomena as to motion, &c., were identical with those of the glaciers of the Alps.

A paper by Mr. E. Delmar Morgan, "On Prijevalsky's Journey through Mongolia," concluded the business of the section.

ECONOMIC SCIENCE AND STATISTICS.—Mrs. Rose Mary Crawshaw read a paper on "Domestic Service for Gentlewomen." After explaining the special reasons which had prevented her from keeping more than one of the five lady helps she had for fifteen months, she stated that from her own experience the actual work done by ladies was greater than that done by other servants. She, however, deprecated a misconception that ladies would become cooks to associate with ordinary servants, and without having provision made for their comfort.

On the re-assembling of this section, it was resolved, on the motion of the President, to recommend the Committee of Council on Education to provide that, in addition to the ordinary rules of arithmetic, candidates should in future be examined in the metric system.

Dr. F. J. Mouat, F.R.S., read a paper, which gave rise to a long discussion, "On the Value of European Life in India in its Political, Social, and Economic Aspects." The writer regarded the risks to life in India of persons sound in constitution and moderately prudent in their habits as not so much in excess of temperate climates as to be a source of anxiety with regard to those who went to make a temporary sojourn in India.

Dr. Beddoe, F.R.S., read two papers—one "On the Mortality of Adolescence," and the other "On the Systematic Examination of the Physical Characters of Men in Britain." The former contained some curious statistics. In the case of males, Dr. Beddoe attributed the excess of mortality to the strain to get a footing in life; and in the case of females partially to the want of care at the critical period incident to boarding-school girl life. In the second paper Dr. Beddoe briefly indicated by reference to questions connected with the Factory Acts, recruiting, &c., the necessity from a practical point of view, and not from that of mere scientific curiosity, of obtaining more extensive and accurate information on the subject than either he or other labourers in the field had been or would be able to collect by their private and unaided investigations. He urged the necessity of making thorough and systematic inquiry into the rates of growth, the average stature, weight, &c., of men and women under normal or abnormal conditions, so as to have a starting point for future investigation and action. In the discussion which ensued several ladies urged that a better class of school-room was required; and Lord Aberdare was of opinion that a higher class of day-school should be provided for girls.

On the motion of Lord Aberdare, it was resolved to take the necessary steps for the appointment of a committee to collect observations on the height and weight of human beings, and to request a grant of money to carry out the scheme. His lordship mentioned that many years ago some such inquiries were made respecting the inhabitants of the three kingdoms; 100 men from each were selected, and it was found that the Irishmen were the tallest and the heaviest men.

The "Influence of the Sun-Spot Period Upon the Price of Corn" formed the subject of a paper by Professor W. Stanley Jevons, F.R.S. After alluding to the attempts made by Mr. Carrington to trace a connexion between the price of corn and the variations in the sun-spots during portions of the last and present centuries, the Professor said that Mr. Schuster has pointed out that the years of good vintage in Western Europe have occurred at intervals approximating to 11 years, the average length of the principal sun-spot period. The elaborate collection of the prices of commodities in all parts of England between the years 1259 and 1400,

published in Professor J. E. T. Rogers's "History of Agriculture and Prices in England," appears to afford the best data for deciding whether the sun-spot period influences the price of corn. For this purpose, tables of the average prices per quarter of wheat and other grain, expressed in grains of pure silver, were used. Each series of prices was divided into intervals of 11 years, which were ranged under each other and averaged, so as to give average of the first, of the second, of the third, &c., years, the commencement of the period being arbitrarily assumed. It is found that the prices of each kind of produce examined rises in the first four years, but afterwards falls. It is further shown that the *maxima* prices are found to fall into the tenth, eleventh, first, second, and third years of the assumed 11-year period. These results are to be looked upon as only preliminary, and need further investigation. It is also pointed out that commercial panics have tended to recur during the last 54 years in a distinctly periodic manner. The average length of interval between the principal panics is about 10.8 years, nearly coinciding with 11.1, the length of the solar-spot period. If Professor Balfour Stewart be right in holding that the sun-spot variation depends on the configuration of the planets, it would appear that these configurations are the remote cause of the greatest commercial disasters.

Papers by Mr. W. Botly, "On Workmen's Dwellings," and by Mr. C. O. G. Napier, "On Legislative Protection to the Birds of Europe," brought the sitting in this Section on Saturday to a close.

Mrs. Gray read a paper on "The National Standard of Education."

Miss Carpenter read a paper on "Industrial Schools." She treated of the reports at the Bristol School Board, and recommended further legislation to enable the effective establishment of a day industrial school.

Mr. S. Morley, M.P., approved the scheme and offered co-operation.

Mr. E. Vivian, M.A., read a paper upon "Vital Statistics," from the experience of the United Kingdom Temperance and General Provident Institution. He showed that, according to the experience of his office (in which statistics of persons insured who were total abstainers were kept separately from the statistics of those who were not), it appeared that the actual deaths in nine years from 1866 to 1874 in the temperance section were about eight-elevenths of the expected deaths by only about 35 out of 2,000 expected.

Major-General Sir J. E. Alexander read a paper on "The Probable Cost of Removing to England the Fallen Obelisk of Alexandria, presented to Great Britain by the Pasha of Egypt." He estimated that it would cost £9,000 to bring the obelisk to England and put it upon the Thames Embankment.

The "Report of the Committee appointed to Consider and Report on the Economic Effects of Combinations of Labourers on Capitalists" was read. The report contained some good advice both to employers and employed, and displayed a spirit of fairness and impartiality in dealing with the subject of trade combinations. The discussion which followed the reading of the report was thoroughly representative of both sides of the labour controversy, and it was conducted throughout in an excellent spirit and with perfect good temper. Sir John Hawkshaw and Mr. Handel Cossham spoke from their experience as large employers of labour, while trades unionism was represented by Mr. Cawsey, a working tailor, and chairman of a trades' council, and by other working men.

MECHANICAL SCIENCE.—The President of the section, Mr. W. Froude, F.R.S., on opening the proceedings, delivered an address, which, following a precedent which has been set on some former

occasions, was confined to the treatment of one subject only. It was an exposition of the fundamental principles which govern the behaviour of fluids, and especially with reference to the resistance of ships, meaning thereby the opposing force which a ship experiences in its progress through the water, a subject to which it is well known Mr. Froude has devoted a large amount of time and thought. In order to make his views clear, he claimed leave to introduce an innovation in presidential addresses, the illustration of what he had to say not only by diagrams, but by the exhibition of actual experiments. Whilst he admitted that improved results in ship-building have been obtained through accumulated experience, it unfortunately happens that many of the theories by which experience is commonly interpreted are interwoven with fundamental fallacies, which, passing for principles, lead to mischievous results when again applied beyond the limits of actual experience. The resistance experienced by ships is but a branch of the general question of the forces which act on a body moving through a fluid, and has, within a comparatively recent period, been placed in an entirely new light by what is commonly called the theory of stream-lines. The theory, as a whole, involves mathematics of the highest order, but, so far as it concerned the resistance of ships, the President considered it could be sufficiently understood without the help of such mathematics. He said: "It is convenient to consider, first, the case of a completely submerged body moving in a straight line with uniform speed through an unlimited ocean of fluid. A fish in deep water, a sounding-lead while descending through the water, if moving at uniform speed, are examples of the case I am dealing with. It is a common belief that a body thus moving experiences resistance to its onward motion by an increase of pressure on its head end, and a diminution of pressure on its tail end. It is thus supposed that the entire head end of the body has to keep on exerting pressure to drive the fluid out of the way, to force a passage for the body, and that the entire tail end has to keep on exerting a kind of suction on the fluid to induce it to close in again—that there is, in fact, what is termed *plus* pressure throughout the head end of the body and *minus* pressure or partial vacuum throughout the tail end. This is not so. The theory of stream-lines discloses the startling truth that a submerged body, if moving at a uniform speed through a perfect fluid, would encounter no resistance whatever." By a perfect fluid, he meant a fluid which is free from viscosity, or quasi-solidity, and in which no friction is caused by the sliding of the particles of the fluid past one another, or past the surface of the body. The property which he described as "quasi-solidity" must not be confused with that which persons have in their minds when they use the term "solid water." When people in this sense speak of water as being "solid," they refer to the sensation of solidity experienced on striking the water surface with the hand, or to the reaction encountered by an oar-blade or propeller. What he meant by "quasi-solidity" is the sort of stiffness which is conspicuous in tar or liquid mud; and this property undoubtedly exists in water, though in a very small degree. But the sensation of solid reaction which is encountered by the hand or the oar-blade is not in any way due to this property, but to the inertia of the water. It is in effect this inertia which is erroneously termed solidity; and this inertia is possessed by the perfect fluid, with which we are going to deal, as fully as by water. Nevertheless, as the President subsequently showed, the perfect fluid would offer no resistance to a submerged body moving through it at a steady speed. It will be seen that the apparent contradiction in terms is cleared up by the circumstance that in the one case we are

dealing with steady motion, and in the other case with the initiation of motion. In the case of a completely submerged body in the midst of an ocean of perfect fluid, unlimited in every direction, it is immaterial whether we consider the body as moving uniformly through the ocean of fluid, or the ocean of fluid as moving uniformly past the body. The proposition that the motion of a body through a perfect fluid is unresisted, or, what is the same thing, that the motion of a perfect fluid past a body has no tendency to push it in the direction in which the fluid is flowing, is a novel one to many persons, and to such it must seem extremely startling. It arises from a general principle of fluid motion—namely, that to cause a perfect fluid to change its condition of flow in any manner whatever, and ultimately to turn to its original condition of flow, does not require, nay, does not admit of, the expenditure of any power, whether the fluid be caused to flow in a curved path, as it must do in order to get round a stationary body which stands in its way, or to flow with altered speed, as it must do in order to get through the local contraction of channel which the presence of the stationary body practically creates. Power, it may indeed be said, is first expended, and force exerted to communicate certain motions to the fluid; but that same power will ultimately be given back, and the force counterbalanced, when the fluid yields up the motion which has been communicated to it, and returns to its original condition. The speaker illustrated this portion of his address with several experiments, in one of which he was assisted by Sir William Thomson, showing that if a chain be set rotating at a high velocity over a pulley, the centrifugal forces did not tend to disturb the path of the running chain, and that a stream of fluid in a tortuous flexible pipe would behave in a strictly analogous manner. He also introduced an experiment to show that in a pipe of varying diameter the pressure of a stream running through it is greater in the wider part than in the contracted portion. The experiments illustrating this fact were remarkable and conclusive. Having thus dealt with the question of a submerged body, he proceeded to the case of a ship travelling at the surface of the water, assuming in the first instance, the action of the fluid if covered with a sheet of rigid ice, and, subsequently, the effect which would follow on its removal. He then pointed out that the causes of resistance to the motion of a ship through the water are—first, surface-friction; secondly, mutual friction of the particles of water (and this is only practically felt when there are features sufficiently abrupt to cause eddies); and, thirdly, wave-genesis; and that these are the only causes of resistance. He also showed that a ship at the surface experiences no resistance in addition to that due to surface-friction and the action of eddies, except that due to the wave she makes. There is an idea, he added, that there exists a form of resistance, a something expressed by the term "direct head-resistance," which is independent of the above-mentioned causes. This idea is so largely prevalent, of such long standing, and at first sight so plausible, that he was anxious not to leave any misunderstanding on the point. The notion of head-resistance, in any ordinary sense of the word, or the notion of any opposing force due to the inertia of the water on the area of the ship's way, a force acted upon and measured by the area of midship section, is, from beginning to end, an entire delusion. No doubt, if two ships are of precisely similar design, the area of midship section may be used as a measure of the resistance, because it is a measure of the size of the ship; and if the ships were similar in every respect, so also would the length of the bowsprit or the height of the mast be a measure of resistance, and for just the same reason. But it is a mistake

to suppose that any part of a ship's resistance is a direct effect of the inertia of the water which has to be displaced from the area of the ship's way. Indirectly, the inertia causes resistance to a ship at the surface, because the pressures due to it make waves. But to a submerged body, or to the submerged portion of a ship travelling beneath rigid ice, no resistance whatever will be caused by the inertia of the water which is pushed aside. The resistance of a ship practically consists of three items, namely, surface-friction, eddy-resistance, and wave-resistance. Of these the first-named is, at least in the case of large ships, much the largest item. The second item of resistance, namely the formation of eddies, he believed is imperceptible to ships as finely formed as most modern iron steamships. The third item is wave-resistance. On this point, the stream-line theory rather suggests tendencies than supplies quantitative results, because, though it indicates the nature of the forces in which the waves originate, the laws of such wave-combinations are so very intricate that they do not enable us to predict what waves will actually be formed under any given condition. In order to reduce wave-resistance, we should make the ship very long. On the other hand, to reduce the surface-friction, it must be made comparatively short, so as to diminish the surface of wetted skin. Thus, as commonly happens in such problems, endeavour is made to reconcile conflicting methods of improvement; and to work out the problem in any given case, we require to know actual quantities. We have sufficient general data from which the skin-resistance can be determined by simple calculation; but the data for determining wave-resistance must be obtained from direct experiments upon different forms to ascertain its value for each form. Such experiments should be directed to determine the wave resistance of all varieties of water-line, cross-section, and proportion of length, breadth, and depth, so as to give the comparative results of different forms as well as the absolute result for each. An exhaustive series of such experiments could not be tried with full-sized ships; but the President trusted that the experiments he was now carrying out with models for the Admiralty are gradually accumulating the data required on this branch of the subject. In conclusion, the President insisted, with the greatest urgency, on the hopeless futility of any attempt to theorize on goodness of form in ships, except under the strong and entirely new light which the doctrine of stream-lines throws on it. It is, he repeated, a simple fact that the whole framework of thought by which the search for improved forms is commonly directed, consists of ideas which, if the doctrine of stream-lines is true, are absolutely delusive and misleading. Real improvements are not seldom attributed to the guidance of those very ideas which he had characterized as delusive, while, in reality, they are the fruit of painstaking, but incorrectly rationalized experience.

The experiments illustrative of the address were of a highly successful character. Mr. Froude, it is understood, has been requested to repeat his illustrations, and give his address in the form of a paper before section A.

The remainder of the day was occupied by two papers, one by Mr. William Denny, "On the Trials of Screw Steamships," the other by Mr. J. T. Thornycroft, "On the Changes of Level of Ships at various Speeds."

The proceedings on Friday were commenced by the reading of a short report of the committee "On the Use of Steel." This committee was appointed with a view of furthering the introduction of steel for use in engineering structures. It appeared that the labours of this committee had been during the year specially directed to urging on the Board of Trade the importance of the

authorities recognizing the use of steel on railways, and laying down a co-efficient for adoption by engineers in designing such works, and suggesting that such co-efficient should be eight tons to the square inch. The correspondence had not yet been brought to a close. An interim report of this committee "On Babbage's Calculating Machine" was presented to the section, simply asking for re-appointment, as, owing to unavoidable circumstances, nothing had been done.

Dr. Woolley read a paper "On the Steering of Ships," giving a very complete resume of the knowledge on this subject at the present time.

Sir W. Thomson then read a memoir prepared by himself and Mr. Hopkinson on methods of giving distinctive character to lighthouses, in which he strongly advocated methods of distinguishing lights by eclipsing the light in a particular manner, giving a number and order of short and long intervals of brilliancy and darkness peculiar to the particular light. They deprecated the use of coloured lights, except where it is necessary to indicate from a light itself the quarter in which it lies, in which case it must show colour in particular directions. In connection with this subject Mr. Hopkinson read a paper on clockwork for revolving lights.

Mr. Beauchamp Tower read a paper on a machine for obtaining motive power from the motion of a ship among waves:—

This machine consists in principle of a weight supported on a spring, so that it can oscillate on the spring through a considerable range into a vertical line. The scale of the spring, and consequently the natural period of oscillation of the weight, can be varied at will. When it is so adjusted that it synchronizes with the waves, the oscillations become very violent, and a large amount of power can be obtained from them. The space occupied by the machine compares favourably with a steam-engine of the same power. The author exhibited a model of the machine, which recently in a moderate sea had yielded power at the rate 1½-horse power per ton of moving weight.

The same gentleman read a paper "On a Revolution Indicator" which he had invented, for the purpose of telling at a glance the rates at which the engines of steamships have been working.

One of the most interesting circumstances connected with the whole meeting was the exhibition in this section, by Mr. J. D. Coven, of toughened glass and certain experiments. A tumbler of the glass thrown on the hard wooden floor did not break, and a weight of half a pound was dropped from a height of some eight feet on a thick plate. He showed that the inequalities of heat that would crack ordinary glass had no effect on the specimen. Another improvement the exhibitor explained was that when sufficient force was used to break the glass it broke into small fragments which did not have the dangerous sharp edges of ordinary glass. Mr. Hopkinson and other members then made some valuable remarks on the structural formation of the glass, which was said, in some respects, to resemble Prince Rupert's drops. The exhibitor then gave a description of the process of toughening by dropping the glass into hot oil.

Professor Osborne Reynolds read an able paper "On Certain Experiments in Respect of the Difficulties of Steering Steam Vessels, particularly those Propelled by Screws." The difficulties, he said, do not occur when the vessel is going ahead, but when stopping or manœuvring to go into harbour, as in the case of the Bessemer, or to avoid collision. He gave an account of some experiments worked with model boats. These experiments led to the conclusion, that in screw steamers the effect of the rudder depends on the direction of motion of the screw rather than on the direction of the motion of the boat. The following laws

might be deduced: that when the screw is going ahead the steamer will turn as if she were going ahead, although she may be going astern; that when the screw is reversed the rudder will act as if the vessel were going astern, although she may be moving forward at the time; that the more rapidly the boat is moving in the opposite direction to that in which the screw is acting, the more nearly will the two effects on the rudder neutralize or destroy each other; that when not breaking the surface the screw will not exert much tendency to turn the ship so long as the rudder is straight; when breaking the surface the screw will tend to turn the stern of the boat in the opposite direction to that in which the tips of the lower blades are moving; that when the boat is going ahead the effects of the screw will be easily counteracted by the rudder, but when starting suddenly the effect of the screw may be greater than that of the rudder.

The paper evoked some discussion, in which it appeared that the results were borne out by the practical experience of Admiral Sir. E. Belcher and Mr. R. T. Napier.

The reading of this paper has led to the appointment of a committee of the association to investigate this subject, which has an important bearing on the safety of life and property at sea.

The next paper was by Mr. R. R. Harper, upon a patent invention for block signalling on railways for the prevention of collisions. Model instruments were exhibited, which appeared simple in their use. The principles on which the invention was founded were technical, but they seemed to meet with general approval from the telegraphic engineers present. Some papers descriptive of the engineering works connected with new docks in the Severn were read. One was by Mr. W. B. Clegram, "On Sharpness Docks," about thirty miles from Gloucester, and communicating with that city by the Berkeley Canal. The docks have been open a short time. Another was "On the Avonmouth Docks," which were not quite complete, by Mr. James Brunlees. The third paper was by Mr. F. Stileman, "On the Portishead Docks," which also have not been completed. A memoir "On the Drifting Power of Tidal Currents versus that of Wind or Waves," by Mr. George Kinahan, and another on the kindred subject of "The Prevention of Sandbars at the Mouth of Harbours," by Mr. C. Bergeron, were read; and Mr. H. Handyside, with the aid of a model, gave a description of his patent steep gradient locomotive, which is being successfully used in the construction of the Avonmouth Docks. The peculiarity of the engine is that by means of a rope and drum, and a sort of foot let down to clasp the rails, the engine can ascend an incline, become a stationary engine, and haul the train after it.

In the afternoon the members of this section paid a visit to the docks at Portishead, now in course of construction by the Bristol and Portishead Railway Company. The weather, unfortunately, was anything but favourable, and the excursionists were glad of the shelter offered by an apartment in which the directors had provided a luncheon, at which Mr. James Ford, chairman of the company, presided, and offered a hearty welcome to the members of the association. After the repast, such of the visitors as were undeterred by a heavy shower, were conducted round the dock works by Mr. J. Ford (chairman), Mr. J. F. K. Daniel (secretary), Mr. Barbenson (resident engineer), and Mr. E. C. Daniel (contractor). Several experienced engineers who were among the party expressed favourable opinions of the works, and extreme confidence in the success of the undertaking.

In the evening Dr. Carpenter gave a lecture in Colston's Hall to a large audience of working men. The subject of the lecture was a piece of limestone. The main object was to show that limestone rock had, whether by coral formation, stratification of shells, or other process, been built up by animals, dead or living, which had derived the lime from water. By means of an electric microscope the lecture was enlivened by numerous illustrations of small pieces of coral formations, fossil shells, and other limestone objects.

A vote of thanks, proposed by Mr. J. H. Clarke, seconded by Mr. Percival, was carried with acclamation; and Mr. Samuel Morley, M.P., made a few remarks on the employment of their recently-acquired leisure by the working classes in scientific recreation.

Mr. Charles Richardson, C.E., read a paper on "The Severn Tunnel," a work undertaken by the Great Western Railway Company for the purpose of connecting their system at Bristol with that in South Wales in the most advantageous and direct way.

The tunnel will be about 4½ miles in length, one-half of which will be under the river Severn. It will connect in the most direct manner the mineral and populous districts of South Wales with Bristol and the South of England, and will doubtless form the express route from London to South Wales. It is, in fact, the missing link in the railway communication of this district. The construction of a bridge across the Severn at this point would be attended with great risk and expense. The bridge must be 100ft. above high water, and must either cross the "Shoots" by one enormous span of 1,300ft., or otherwise involve the placing of two piers in this swift channel, here 100ft. deep at high water, and then the central span must be 700ft. or 800ft. Mr. Richardson proceeded to state that the shaft was begun in March, 1873. The bottom of the shaft was reached and the heading started in December, 1874. As it was decided to drive the heading by the use of the new rock drill, the air pumps and other machinery necessary for this purpose had to be procured and fixed in place. The M'Kean drills were set to work at the end of January, 1875. These drills were entirely new to the men, and they were at first prejudiced against their use. However, the air-pump happened to break down, and the men had to go to work for a few shifts in the old style. Their eyes were then opened. They appeared to themselves to be doing nothing. Dynamite was also used instead of the old-fashioned blasting powder. The men now worked in three eight-hour shifts, and accomplished from fourteen to eighteen yards in the week. In conclusion Mr. Richardson observed that probably the whole of that part of the tunnel which will be under the "Shoots" will have to be cut through the hard pennant sandstone. A good, strong, and self-supporting rock like this makes a most favourable ground for the construction of the Severn Tunnel.

In the evening Mr. F. J. Bramwell delivered a lecture on "Railway Safety Appliances."

In the morning a large party, consisting chiefly of those who have been attending the sittings of the Mechanical Science Section of the British Association, made an excursion to Avonmouth, chiefly for the purpose of seeing Handyside's steep-gradient locomotive (a paper upon which was read on Saturday) at work, but having with them Mr. Brunlees, the engineer of the Avonmouth Docks, the party availed themselves of the opportunity of inspecting the docks works, where at present upwards of 800 men are employed. The train returned to Clifton in time for the sitting of the various sections.

The report of the committee "On Sewage Utilization," previously taken in the Chemical, was now read by Mr. Richard

Grantham in this section, the committee being a joint one, representing both sections.

The "Water Supply to the Villages of the Central and Eastern Counties" was then discussed in a paper by Prof. Hull, who pointed out, from the geological formations pervading those districts, that good water could readily be obtained by wells. An animated discussion took place, in which it was pointed out that although doubtless, speaking generally, a good supply could be obtained, the great difficulty to overcome was the financial one involved in the cost of distribution. With reference to the Lower Greensand, a formation specially referred to by Prof. Hull as offering peculiar facilities for an excellent supply, Mr. Dines and Mr. M. Le Neve Foster gave instances where the water thus obtained was of a filthy character and wholly unfit for domestic use. Mr. F. Ashmead then gave a description of "the Sewage of Bristol;" a "Sewer Trap" was described by Mr. Thomas Hudson; the new "Joint Station" for Bristol formed the subject of an elaborate paper by Mr. Francis Fox, which was read by Mr. Scoones. Mr. Smith and Mr. Browne severally brought before the section papers descriptive of means for "Communication between Passengers and Guard," and Mr. Braham showed a plan for producing "audible signals" on railways.

General Carrington, U.S.A., read a paper "On Chrome Steel." He said it was a new alloy of iron with the oxide of chromium, and that it was a greater advance than had yet been made towards a perfect metal. He described experiments which had been made upon it to prove its strength, and said that while it could not be pierced by other steel, he had never yet seen the steel that a drill of the chrome steel would not pierce in three minutes.

The section held a sitting on Wednesday, in order to complete its work which, for want of time, had stood over from Tuesday. "The Channel Tunnel" was the subject of a paper by Mr. W. Topley.

At a committee meeting held at the Museum Library and Lecture Theatre, under the presidency of Sir John Hawkshaw, deputations were received inviting the society to hold the 1877 meeting in Plymouth and Leeds. The former town was selected, and Sir Robert Christison was elected President for the Glasgow meeting, which will commence on the 6th September next year.

In our last we gave the list of sectional office-bearers up to the date of our going to press. We now give a complete list:—

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